Quarterly Bulletin

Vol. 41, No. 3
February
1959

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MICHIGAN STATE UNIVERSITY
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THE QUARTERLY BULLETIN

VOLUME 41 • NUMBER 3 • FEBRUARY 1959

MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
EAST LANSING

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SOME ECONOMIC ASPECTS OF PIE CONSUMPTION[1]

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DEPARTMENT OF AGRICULTURAL ECONOMICS

BACK IN GRANDMOTHER'S DAY — or at least in great-grandmother's day—most of the pies consumed in the home were baked in the home. Today a substantial portion of pies is purchased ready-baked or ready for the oven. Growth of commercial pie preparation has added a new dimension to the marketing process. Considerable volumes of fruit that would flow to the consumer in raw or processed form are diverted to pastry firms and the housewife finally buys her fruit with an added service attached.

This report presents the results of a detailed study of the way in which commercially prepared pies are purchased or used by a group of urban families. Aspects considered include current levels and trends in consumption of various kinds of pies, percent of families buying, seasonal patterns of consumption, frequency of consumption, prices and price relations, and relation of consumption to various socio-economic characteristics of families.

The principal source of information is the food consumption records of the M.S.U. Consumer Panel, a group of about 250 urban families selected to be representative of a Michigan city of about 100,000 population.[2]

Although the consumption habits of these families are not typical of those in all of the United States, their purchase patterns are likely to be representative of the North Central Region and may shed a good deal of light on many aspects of consumption throughout the market.

[1]M.S.U. Consumer Panel Report No. 51. The M.S.U. Consumer Panel is operated under the direction of G. G. Quackenbush.

[2]These families make itemized weekly reports of the quantity, price, and expenditure for each item purchased for home consumption during the week. They also report all food received as a gift or homegrown which is used for home consumption. For additional information about the operation of the Panel, see Shaffer, J. D. (1954). A plan for sampling a changing population over time. Jour. Farm Econ. 30: 153-163; and Shaffer, J. D. and G. G. Quackenbush (1955). Cooperation and sampling in 4 years of the MSU Consumer Panel operation. Mich. State Agr. Expt. Sta. Quart. Bul. 38: 85-103.

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Supplementary information on the general level of commercial pie consumption in the United States has been obtained from a recent U.S.D.A. survey.[3] Although lacking in detail, the U.S.D.A. data provide a check on the M.S.U. Panel figures and give an indication of regional variations in total consumption.

Per Capita Consumption

Total home consumption of commercially prepared pies varied from 1.5 pounds per person in 1953 to 2.36 pounds in 1955 (Table 1). Following a large increase from 1953 to 1954 consumption has averaged about two and one-fourth pounds per person. Apple and cherry pies account for about half of the pies purchased.[4]

TABLE 1—Per capita consumption of commercially prepared pies, M.S.U. consumer panel families, 1953-1957

Type of pie	1953	1954	1955	1956	1957
			Pounds		
Apple	.40	.58	.67	.65	.71
Blueberry	.09	.21	.21	.21	.13
Cherry	.32	.53	.58	.46	.57
Pineapple	.07	.15	.11	.10	.11
Berry	.03	.08	.11	.08	.09
Other fruit	.15	.11	.26	.25	.32
Total fruit	1.06	1.66	1.94	1.75	1.93
Pumpkin	.18	.15	.14	.13	.15
Mincemeat	.09	.05	.08	.08	.05
Cream and custards(*a*)	.17	.21	.20	.22	.12
Other non-fruit(*b*)	—	—	—	.03	.08
Total non-fruit	.44	.41	.42	.46	.40
Total	1.50	2.07	2.36	2.21	2.33

(*a*) Includes chiffon pie.
(*b*) Unclassified pies, probably mostly cream, custard and chiffon.

Percent of Families Buying

Roughly, two families out of three purchase commercially prepared pie at some time during a year (Table 2). Most of these families buy some fruit pies, especially apple and cherry.

[3] *Food Consumption of Households*, Household Food Consumption Survey, 1955. Reports No. 1, 2, 3, 45. U.S.D.A., A.R.S. and A.M.S., December, 1956.
[4] A family size pie typically weighs about 1.5 pounds; small individual pies weigh about two tenths of a pound.

TABLE 2—Percent of families buying commercially prepared pies, by type of pie, M.S.U. consumer panel, 1953-1957(a)

Type of pie	1953	1954	1955	1956	1957
Apple	22	36	39	39	45
Blueberry	11	23	33	27	18
Cherry	21	42	41	40	44
Pineapple	7	14	12	14	14
Berry	5	8	13	12	12
Other fruit	10	18	31	25	26
Total fruit	37	56	61	66	63
Pumpkin	8	12	10	13	19
Mincemeat	6	10	11	12	11
Cream and custards(b)	16	17	13	13	11
Other non-fruit(c)	—	—	—	6	11
Total non-fruit	23	27	22	30	32
Total	53	61	62	67	65

(a) Does not include gifts.
(b) Includes chiffon.
(c) Unclassified pies, probably mostly cream, custard and chiffon.

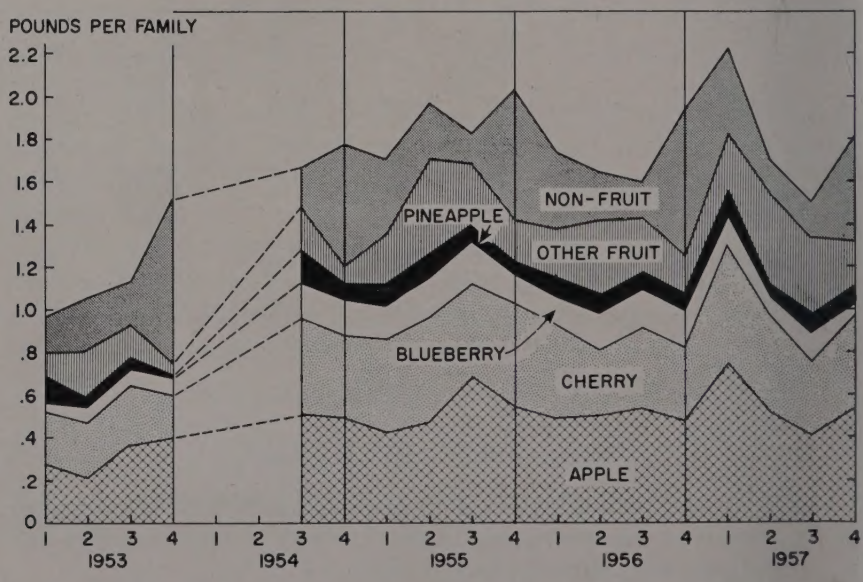

Fig. 1. Quarterly purchases of commercially prepared pies by M.S.U. Consumer Panel families, 1953-1957. Shaded sections show purchases of various types of pies.

Quarterly Distribution of Consumption

Fig. 1 shows the variation in pie purchases per family by quarterly periods. Quarterly data were not available for the first two periods of 1954. Consumption trended upward rapidly from 1953 to 1955, apparently reflecting the increased availability of frozen pies and bakery lines in super markets.

Relative variations in purchases of different kinds of pies are given in Table 3. The share of the market allocated to various types of pies has fluctuated somewhat, but no trends in market shares are evident from these figures. As might be expected relative purchases of fruit pies are reduced during the fourth quarter and mince and pumpkin increased.

Prices and Price Relationships

Quarterly average prices paid for different kinds of pies by panel families are given in Table 4. For pies such as apple and cherry,

TABLE 3—Percentage distribution of purchases of commercially prepared pies, M.S.U. consumer panel families, by quarters, 1953-1957

Year and quarter	Apple	Blue-berry	Cherry	Pine-apple	Berry	Other fruit	All fruit	Pump-kin	Mince	Cream and cus-tards (a)	Other non-fruit (b)	All non-fruit	Total
	Percent												
1953 1	29	5	24	13	1	11	83	4	1	12		17	100
2	20	7	25	5	1	19	77	5	*	18		23	100
3	31	7	25	5	3	11	82	*	6	12		18	100
4	27	5	13	*	2	3	50	30	13	7		50	100
1954 1													
2													
3	31	10	27	9	5	6	88	2	*	9		11	100
4	28	9	22	3	2	3	67	19	6	8		33	100
1955 1	25	9	26	6	4	10	80	6	3	11		20	100
2	24	9	25	6	5	18	87	2	1	10		13	100
3	37	11	24	4	6	10	92	2	*	5		8	100
4	27	7	24	3	3	6	70	13	8	9		30	100
1956 1	29	8	25	4	2	11	79	5	4	11	1	21	100
2	31	11	19	5	6	14	86	1	1	10	2	14	100
3	34	11	23	5	4	12	89	2	*	7	2	11	100
4	25	8	18	4	2	8	65	16	8	11	*	35	100
1957 1	34	6	25	5	2	10	82	7	3	6	2	18	100
2	31	5	26	3	5	20	90	1	1	6	2	10	100
3	27	9	23	6	5	19	89	2	*	5	4	11	100
4	29	4	24	4	3	8	72	15	4	4	5	28	100

(a) Includes chiffon.
(b) Unclassified, probably mostly cream, custard and chiffon.
* Less than 0.5 percent.

which are purchased by a large percentage of the families, the prices are probably representative of prices prevailing in the urban area. Prices for the less frequently purchased pies are based on small samples and may reflect individual store specials or quality variations. The prices of all types of pies averaged close to 38 cents per pound over the period studied. An exception is the price of blueberry pies which has been consistently above the prices of other pies.

TABLE 4—Average prices paid for commercially prepared pies, M.S.U. consumer panel families, 1953-1957

Year and quarter	Type of pie											
	Apple	Blue-berry	Cherry	Pine-apple	Berry	Other fruit	All fruit	Pump-kin	Mince	Cream and custard	All non-fruit	All pies
	Cents per pound, product weight											
1953 1	39	37	36	37	46	42	38	38	*	38	40	39
2	38	44	37	40	42	35	38	35	*	35	36	38
3	43	50	43	32	34	42	42	*	48	37	39	42
4	38	45	39	50	27	52	39	34	31	38	34	37
1954 1(*a*)												
2(*a*)												
3	35	43	36	36	34	35	36	33	*	36	35	36
4	34	43	35	42	35	22	36	34	42	37	37	36
1955 1	37	39	37	38	35	38	37	39	38	36	37	37
2	37	38	38	38	37	36	37	40	33	37	37	37
3	36	48	38	39	35	36	37	34	*	39	39	37
4	36	38	37	38	36	35	36	35	40	36	37	37
1956 1	35	43	39	40	42	35	38	38	39	37	39	38
2	35	39	37	37	35	37	36	45	38	36	40	37
3	35	35	36	36	31	38	36	32	*	37	38	36
4	37	41	37	34	36	40	38	33	37	36	35	37
1957 1	33	38	34	36	41	37	35	33	38	40	37	35
2	39	41	38	37	38	37	38	37	40	45	45	39
3	39	48	40	32	36	43	41	38	*	44	39	40
4	36	39	37	37	39	43	37	37	38	48	41	38
Average	37	42	37	38	37	38	38	36	39	38	38	38

(*a*) Data for first half of 1954 not available.
* Purchases during the period insufficient to estimate price.

Statistical analysis indicates that for the period studied the relation of average price paid and purchases of *all fruit pies* was as follows:[5]

[5]The following least-squares regression equation was fitted to quarterly data for the period 1953-1957.

$$X_1 = 3.9258 - .0765X_2 + .0324X_3 - .2454X_4$$
$$(3.1070) \quad (4.4010) \quad (2.6188)(a)$$

where X_1 = average quantity of fruit pies consumed per family per quarter, pounds
X_2 = average price of all fruit pies
X_3 = time, period 1, 1953 = 0
X_4 = 0 in periods 1, 2 and 3
1 in period 4

Figures in parentheses are t ratios and $\bar{R} = .83$

(a) a change of one cent in the average price paid has been associated with a change in the opposite direction of about .076 pounds in the average quarterly purchases per family.

(b) purchases have trended upward at an average rate of .032 pounds per family per quarter.

(c) Consumption of fruit pies per family has dropped about .245 pounds per family during the fourth quarter of each year as mince and pumpkin pies are substituted during the Thanksgiving and Christmas holidays.

Expressed in percentage terms, measured at the average price and quantity, a 10 percent change in the average price of fruit pies has been associated with about a 21 percent change in quantity consumed, in the opposite direction.

Limitations of the data have precluded any meaningful analysis of price and substitution relations for and among individual types of pies.

Individual Family Purchase Patterns

Variations in the frequency with which families purchase various kinds of pies are given in Table 5. The table shows, for example, that in 1957, 30 percent of families bought no pies, 12 percent purchased

TABLE 5—Frequency of purchase or use of commercially prepared pies, M.S.U. consumer panel families, 1957(a)

Type of pie	Number of weeks purchased or used per year								Average number of times purchased or used per year	
	0	1	2	3	4	5	6	Over 6	All families	Only families using
	Percent of families									
Apple	52	20	11	4	3	3	1	6	1.35	2.81
Blueberry	82	12	3	1	*	1	*	1	.34	1.89
Cherry	54	18	11	4	6	2	1	4	1.24	2.70
Pineapple	86	6	4	1	1	*	1	1	.35	2.50
Berry	88	8	1	1	1	*	*	1	.25	2.08
Other fruit	72	16	4	3	1	1	1	2	.64	2.29
All fruit	33	13	16	5	4	5	5	18	2.75	4.10
Pumpkin	80	15	1	2	1	1	*	0	.32	1.60
Mince	88	9	1	1	1	0	0	0	.18	1.50
Cream and custard	88	8	2	1	0	0	0	1	.23	1.92
Other non-fruit	87	8	3	2	0	0	*	0	.20	1.54
All non-fruit	64	19	7	3	1	3	0	3	.85	2.36
Total	30	12	13	8	5	5	3	23	3.13	4.47

(a) Includes gifts as well as purchases.
* Less than 0.5 percent.

pies once and 45 percent bought pies three or more times. However, with the exception of apple and cherry pies, few families purchased the same kind of pie more than once or twice.

A further indication of the variation in variety of pies purchased is given in Table 6.

TABLE 6—Variation in variety of pies purchased or used by M.S.U. consumer panel members, 1953-1957

Variation	1953	1954	1955	1956	1957
	Percent of families				
Fruit only	18	30	38	37	33
Non-fruit only	7	6	4	1	3
1 variety	17	22	14	16	16
2 varieties	15	12	14	17	18
3 varieties	7	9	12	12	12
4 varieties	7	6	10	9	7
5 varieties	3	5	6	6	6
Over 5 varieties	7	2	9	9	10

Relations of Consumption to Socio-Economic Characteristics of Families

Consumption of commercially prepared pies appears to be associated with income, size of family, age of the homemaker and the employment status of the homemaker. To investigate the nature of this relationship families have been grouped into relatively homogeneous classes and the per family and per capita consumption calculated for each group. The unit of observation is a family-year taken over a five-year period. Thus some families may be represented five times. Most remain in the same class, but if socio-economic characteristics change sufficiently a family may appear in more than one class. The results are given in Tables 7 and 8.

Some classes contain no families and others only a few. However, study of the tables suggests some general tendencies.[6]

(1) Both consumption per family and consumption per person increase substantially as income increases from a low to a moderate level. Thereafter, increases in income do not seem

[6]Because of the complexity of the tables and limitations of the data, elaborate statistical tests of differences among cells resulting from the cross classification did not seem warranted. Attention is focused on the over-all rather than specific differences.

TABLE 7—Relation of annual per family consumption of commercially prepared pies to selected family characteristics, M.S.U. consumer panel, 1953-1957

Number of persons in family	Age of homemaker	Homemaker employed					Homemaker not employed					Grand Avg.(*a*)
		Annual income per family—1000 dollars										
		0-2.9	3-5.9	6-8.9	9-11.9	Avg.(*a*)	0-2.9	3-5.9	6-8.9	9-11.9	Avg.(*a*)	
		Pounds per family										
1-2	20-39	—	2.4	.4(*b*)	—	1.8	1.5(*b*)	2.3	.9(*b*)	—	1.9	1.9
	40-59	1.0	7.7	4.2	14.5	5.4	3.5	9.1	6.1	5.7	7.6	6.9
	60-79	2.2	21.1	18.1(*b*)	—	8.1	4.7	5.7	4.8	5.1(*b*)	5.0	5.7
	Average(*a*)	1.9	9.8	4.8	14.5	5.9	4.4	7.5	5.5	5.6	6.0	6.0
3-4	20-39	—	4.6	14.7	24.5	12.4	.9(*b*)	3.6	10.0	4.6	5.2	6.1
	40-59	3.1(*b*)	11.8	21.4	5.6	13.9	2.3	6.8	5.1	4.5	5.5	7.2
	60-79	—	13.1(*b*)	4.7(*b*)	—	7.5	9.0(*b*)	9.7	4.4(*b*)	.7(*b*)	7.8	7.7
	Average(*a*)	3.1	8.4	17.4	14.2	12.9	2.4	4.7	7.6	4.4	5.4	6.6
5 and over	20-39	—	.0(*b*)	29.5	24.3	24.9	7.6(*b*)	2.2	2.7	3.7	2.6	5.1
	40-59	—	.7(*b*)	3.3(*b*)	34.8(*b*)	14.0	11.2(*b*)	5.6	3.0	13.2	6.0	7.8
	60-79	—	—	—	—	—	—	35.5(*b*)	6.3(*b*)	—	25.7(*b*)	25.7
	Average(*a*)	—	.5	19.0	29.0	19.7	9.4	3.9	2.8	8.0	4.1	6.3
Grand Average(*a*)		2.0	8.8	10.9	19.8	9.5	4.3	5.5	5.9	5.4	5.4	6.3

(*a*) Weighted by number of families in each class.
(*b*) Figures based on less than five families.

TABLE 8—Relation of annual per capita consumption of commercially prepared pies to selected family characteristics, M.S.U. consumer panel, 1953-1957

Number of persons in family	Age of homemaker	Homemaker employed					Homemaker not employed					Grand Avg.(*a*)
		Annual income per family—1000 dollars										
		0-2.9	3-5.9	6-8.9	9-11.9	Avg.(*a*)	0-2.9	3-5.9	6-8.9	9-11.9	Avg.(*a*)	
		Pounds per capita										
1-2	20-39	—	1.4	.2(*b*)	—	1.1	.8(*b*)	1.2	.5(*b*)	—	1.0	1.0
	40-59	.9	4.8	2.1	7.2	3.0	1.9	4.5	3.0	2.8	3.8	3.5
	60-79	1.8	11.1	9.1(*b*)	—	4.6	3.1	2.9	2.3	2.6(*b*)	3.0	3.3
	Average(*a*)	1.5	5.6	2.4	7.2	3.3	2.8	3.8	2.7	2.8	3.2	3.3
3-4	20-39	—	1.2	3.8	6.8	3.3	.2(*b*)	1.0	2.6	1.4	1.4	1.6
	40-59	.9(*b*)	3.2	6.0	1.6	3.9	.7	2.1	1.4	1.3	1.6	2.1
	60-79	—	3.8(*b*)	1.2(*b*)	—	2.1	3.0(*b*)	2.8	1.4(*b*)	.2(*b*)	2.3	2.3
	Average(*a*)	.9	2.3	4.8	4.0	3.6	.7	1.3	2.0	1.3	1.5	1.8
5 and over	20-39	—	.0(*b*)	4.7	4.1	4.0	1.5(*b*)	.4	.5	.6	.5	.9
	40-59	—	.2(*b*)	.7(*b*)	6.5(*b*)	2.7	2.1(*b*)	1.0	.5	2.6	1.1	1.5
	60-79	—	—	—	—	—	—	7.1(*b*)	1.3(*b*)	—	5.2(*b*)	5.2
	Average(*a*)	—	.1	3.1	5.2	3.4	1.8	.7	.5	1.5	.7	1.1
Grand Average(*a*)		1.5	4.1	3.3	5.0	3.4	2.5	2.1	1.8	1.6	2.1	2.4

(*a*) Weighted by number of families in each class.
(*b*) Figures based on less than five families.

to be associated with increased consumption. Families of five or more persons show no association of income and consumption, but the sample of families in these classes is small.

(2) Both consumption per family and consumption per person tend to increase with increases in the age of the homemaker. This tendency is most pronounced in the lower and middle income groups. The lower level of consumption in households where the homemaker is under 40 seems surprising but is quite evident in the data.

(3) Per capita consumption tends to decrease with increases in family size. Consumption per family does not appear to be associated closely with family size for this group of families.

(4) For families of three or more persons, consumption by households where the homemaker is employed is roughly twice that of households where she is not employed outside the home. For one and two person families, there appears to be little association of consumption and employment status.

Table 9 gives an indication of differences in average characteristics of family buying different kinds of pies. The principle differences are:

(a) Families buying blueberry pies have, on the average, larger incomes, larger families, greater education and are slightly younger than families buying other kinds of pies.

TABLE 9—Characteristics of families purchasing commercially prepared pies, by type of pie, M.S.U. consumer panel, 1953-1957 average

Type of pie purchased	Average annual income **	Average size of family *	Average age of homemaker *	Average education of homemaker ‡	Percent of homemakers employed ***
Apple	$5,590	3.16	47.2	11.6	23.9
Blueberry	6,010	3.25	46.3	12.0	23.7
Cherry	5,700	3.16	47.4	11.7	21.3
Other fruit	5,490	3.13	47.7	11.5	27.3
All fruit	5,540	3.17	46.7	11.7	22.5
Non-fruit	5,510	3.05	48.3	11.6	24.8
All pies	5,500	3.18	46.9	11.6	22.0
Not purchasing	4,670	2.99	49.4	11.4	19.3

* Differences significant at 1 per cent level.
** Differences significant at 5 percent level.
*** Differences significant at 10 percent level.
‡ Differences not statistically significant.
Significance of differences was tested using Friedmann's analysis of variance by ranks. Annual means for five years were ranked each year.

(b) Families not buying any commercially prepared pies have, on the average, smaller incomes, smaller size, a smaller percentage of homemakers employed and the homemaker tends to be slightly older than for the families that buy commercially prepared pies. The older age for the non-purchaser seems contradictory to the relations shown in Tables 7 and 8. The answer seems to be that if older homemakers purchase pies at all they purchase in somewhat larger quantities than the younger group.

Comparison of M.S.U. Panel and United States Consumption

Tables 10, 11 and 12 compare consumption of commercially prepared pies by M.S.U. panel families with estimates of consumption in the 1955 U.S.D.A. survey of households. The data refer to the aggregate of all kinds of commercially prepared pies. Home baked pies are not included.

TABLE 10—Percentage of households using commercially prepared pies during one week, April-June, 1955, M.S.U. consumer panel and U.S.D.A. food consumption survey, urban households

Household size and annual income after taxes	M.S.U. consumer panel(*a*)	U.S.D.A. Survey				
		North-Central region	North-east	South	West	United States
	Percentage of household using					
All households	9.5	9.3	19.4	8.5	12.4	12.8
1-person households	5.2	6.1	10.0	5.6	4.9	6.9
Households of 2 or more persons	10.4	9.6	20.3	8.8	13.3	13.4
Under $2,000	4.2	7.3	10.9	4.3	20.0	7.6
2,000—2,999	5.0	0.0	18.3	7.3	16.7	9.7
3,000—3,999	9.8	5.7	18.4	12.9	14.9	13.2
4,000—4,999	9.1	5.6	22.3	5.7	13.6	12.7
5,000—5,999	11.3	12.4	21.9	8.0	10.4	14.7
6,000—7,999	11.0	17.1	23.4	13.3	7.1	17.2
8,000—9,999	12.9	8.9	28.6	5.3	22.2	16.2
10,000 and over	13.0	16.1	13.9	15.4	16.1	15.5

(*a*) Figures for all households are averages for the second quarter of 1955. Figures by income class are averages for the year 1955.

Source of U.S.D.A. data: *Food Consumption of Households*, Household Food Consumption Survey, 1955, Reports number 1, 2, 3, 4, 5, U.S.D.A., ARS and AMS, December, 1956.

TABLE 11—Average quantity of commercially prepared pies used during one week, April-June, 1955, M.S.U. consumer panel families and U.S.D.A. food consumption survey, urban households

Household size and annual income after taxes	M.S.U. consumer panel(*a*)	U.S.D.A. Survey				
		North-Central region	North-east	South	West	United States
	Pounds per household					
All households	.14	.15	.35	.14	.30	.23
1-person households	.03	.06	.13	.09	.05	.09
Households of 2 or more persons	.15	.16	.37	.15	.33	.25
Under $2,000	.03	.13	.13	.07	.34	.12
2,000—2,999	.08	.00	.25	.11	.37	.15
3,000—3,999	.14	.11	.40	.17	.53	.28
4,000—4,999	.12	.10	.38	.07	.27	.22
5,000—5,999	.18	.23	.33	.12	.18	.24
6,000—7,999	.12	.23	.55	.26	.19	.33
8,000—9,999	.24	.18	.54	.11	.48	.32
10,000 and over	.19	.25	.20	.65	.60	.35

(*a*) Figures for all households are averages for the second quarter of 1955.
Figures by income classes are averages for the year 1955.
Source of U.S.D.A. data: *Food Consumption of Households*, Household Food Consumption Survey, 1955. Reports number 1, 2, 3, 4, 5, U.S.D.A., ARS and AMS. December, 1956.

The M.S.U. panel figures and the U.S.D.A. estimates for the North-Central region for all households, show a very close agreement.[7] As the data are broken into income groups the sample sizes become smaller and differences due to sampling variation increase. However, the same tendency and general levels are apparent in both. In all cases, as was demonstrated previously, consumption, expenditure and the percent of families using commercial pies tend to increase as income increases, particularly in the lower ranges of income.

Looking at regional variations, purchases of commercially prepared pies are greatest in the Northeast and least in the South. Surprisingly, consumption in the North-Central region is only slightly above the quantity recorded for the South.

[7]The U.S.D.A. figures are based on family recollections of purchases during one week, (April-June 1955) but not necessarily the same week for all families. The M.S.U. panel figures represent average purchases taken over the entire period. Since consumption rates appear to be fairly uniform throughout the April-June period the one week recall and average weekly records of purchases should be generally comparable.

TABLE 12—Average expenditure on commercially prepared pies used during one week, April-June, 1955, M.S.U. consumer panel families and U.S.D.A. food consumption survey, urban households

Household size and annual income after taxes	M.S.U. consumer panel(a)	U.S.D.A. Survey				
		North-Central region	North-east	South	West	United States
	Dollars per household					
All households	.05	.06	.12	.05	.11	.08
1-person households	.01	.03	.05	.04	.02	.04
Households of 2 or more persons	.05	.06	.13	.05	.12	.09
Under $2,000	.01	.05	.05	.02	.11	.04
2,000—2,999	.03	.00	.09	.04	.13	.05
3,000—3,999	.05	.04	.13	.06	.16	.09
4,000—4,999	.04	.04	.14	.03	.08	.08
5,000—5,999	.06	.08	.12	.03	.08	.09
6,000—7,999	.05	.09	.18	.08	.06	.11
8,000—9,999	.09	.07	.18	.05	.17	.11
10,000 and over	.07	.13	.09	.24	.30	.17

(a) Figures for all households are averages for the second quarter of 1955. Figures by income classes are averages for the year 1955.

Source of U.S.D.A. data: *Food Consumption of Households*, Household Food Consumption Survey, 1955. Reports number 1, 2, 3, 4, 5, U.S.D.A., ARS and AMS, December, 1956.

THE NONFAMILY MARKET FOR CHRISTMAS TREES IN LANSING, MICHIGAN

By LEE M. JAMES
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A GREAT DEAL of literature has appeared in recent years describing various aspects of the Christmas tree market. Virtually all of the studies made have assumed that Christmas trees are destined for use in the home. The nonfamily market has been pretty much ignored.

This report presents the results of a survey of the nonfamily market for Christmas trees in one urban area—Lansing, Michigan. One urban area cannot be presumed to reflect conditions in other urban markets, but in the absence of a general study or other specific-area studies, the findings reported here may be considered indicative of the general nonfamily market for Christmas trees in Michigan. The study was conducted by the Department of Forestry, Michigan State University, and represents a cooperative effort between the Michigan Agricultural Experiment Station and the North Central Regional Technical Committee.[1]

Questionnaires were mailed in January 1958 to a sample of the establishments listed in the yellow-page section of the Lansing telephone directory. Three listings were drawn at random from each of the 352 yellow pages. Eliminating duplications, the sample totaled 1,025 listings; it represented 10.5 percent of the total population of 9,700 separate establishments listed in the yellow-page section of the directory. Returns were obtained from 585 establishments—58 percent of the net mailing and 6 percent of the total number of establishments.

[1]This project has been supported in part by regional research funds provided under federal acts authorizing cooperative research by state agricultural experiment stations. It has been approved by the North Central Regional Technical Committee as a contribution to NCM-20, the Cooperative Regional Research Project on Christmas tree marketing.

ARTICLE 41-54

Extent of Nonfamily Use of Christmas Trees

On the basis of the sample returns from 585 establishments, the Lansing nonfamily market accounted for 6,135 Christmas trees in 1957. With a population of some 120,000 persons in the Lansing area, nonfamily use of Christmas trees is calculated at 1 tree per 19.5 persons.

Nonfamily use can be compared directly with family use in the Lansing area. A 1956 survey of 300 families selected systematically from the Lansing telephone directory showed home consumption of Christmas trees to average 1 tree per 4.6 persons, or a total of 26,100 trees for the 120,000 persons in the Lansing area. Thus, nonfamily use makes up 19 percent of all Christmas tree consumption (Table 1).

TABLE 1—Nonfamily use compared with family use of Christmas trees in the Lansing area

	Christmas trees used		Persons per tree
	Number	Percent	Ratio
Family.....	26,100	81	4.6
Nonfamily.....	6,135	19	19.5
Total.....	32,235	100	3.7

Nonfamily Users of Christmas Trees

Nonfamily use of Christmas trees varies by kind of establishment (Table 2). One-fourth of all establishments display at least one Christmas tree. The proportion is not greatly different for stores, professional services, general services and miscellaneous sales outlets; but it is lower for manufacturing plants and considerably higher for public institutions. Most establishments displaying trees have only one tree, but the averages are raised in nearly all categories by establishments with larger displays. Retail stores, for example, average more than 4 trees per store with trees on display; one department store sampled had 33 trees, and another, had 25 trees. The average of nearly 10 trees per establishment among public institutions is weighted most heavily by the public schools. All of the schools sampled used a number of trees; frequently, one tree for every classroom.

TABLE 2—Christmas trees displayed by kind of establishment, 1957

Kind of establishment	Establishments displaying trees		Trees displayed[1]	
	Percent	Ratio of trees to establishments	Number	Percent
Stores[2]	20	4.19	1,874	31
Professional Services[3]	27	1.41	564	9
General Services[4]	26	1.24	1,094	18
Miscellaneous sales outlets[5]	23	1.10	348	6
Manufacturing plants	16	1.00	83	1
Public institutions[6]	86	9.92	1,973	32
Unknown	24	2.40	199	3
Total	25	2.55	6,135	100

[1]Number of trees displayed in each kind of establishment was calculated by multiplying the number of trees displayed in sampled establishments by 16.58, the overall expansion factor. It would have been more correct to use a separate expansion factor for each kind of establishment, but there was no ready method of calculating the population of each kind of establishment.
[2]Retail establishments.
[3]Law, medicine, engineering, architecture, insurance, accounting, banking.
[4]Repairing, laundering, cleaning, plumbing, barbering, printing, hotels and transportation.
[5]Building and construction materials outlets, automotive supplies, wholesale distributors.
[6]Public buildings and offices, including public schools as most important category.

The calculations of tree totals have the surprising result of showing public institutions in first place, ahead of retail stores. It is not uncommon to find 20 to 25 trees in each public school displaying trees. This reflects the influence of PTA organizations which are the most common source of funds for Christmas tree purchases by schools.

Method of Tree Acquisition

Purchase is overwhelmingly the chief method by which trees are acquired in the nonfamily market. About 95 percent of the trees displayed are purchased from growers, retailers or wholesalers; 4 percent are gifts; and 1 percent are obtained from the displayers' own properties.

Types of Trees Used

Eighty-eight percent of the trees used in the nonfamily market are untreated, natural trees. Treated, natural trees have been increasing in popularity, but still comprise a small portion of the total: painted trees, 3 percent; flocked trees, 1 percent; and table model trees

(usually painted and sold with stands), 5 percent. Balled and burlapped trees, suitable for later planting, are vitually non-existent in the Lansing market.

Artificial trees account for 3 percent of the trees used in the non-family market. So far, at least, they have offered little competition to natural trees. Their disadvantages of appearance, high price, and storage problems have restricted them to a minor role in the Christmas tree market.

Distribution of types of trees by kind of establishment is shown in Table 3. Untreated, natural trees are most popular in all kinds of establishments, with the possible exception of manufacturing plants. Use of painted trees is confined mainly to two categories of establishments—professional services and miscellaneous sales outlets. Flocked trees are few, and are confined to retail stores, professional services and general services. Table model trees have gained some acceptance in most kinds of establishments, but it is notable that none were reported in retail stores. Artificial trees make up a significant proportion of the total only in the category of manufacturing plants, but the total number of trees displayed in these plants is very small.

TABLE 3—Types of Christmas trees displayed by kind of establishment, 1957

Kind of establishment	Types of trees						
	Untreated, natural	Painted	Flocked	Balled and burlapped	Table model	Artificial	All types
	(Percent)						
Stores	92	2	2	1	0	3	100
Professional services	73	9	6	0	9	3	100
General services	72	2	2	0	16	8	100
Miscellaneous sales outlets	80	10	0	0	10	0	100
Manufacturing plants	50	0	0	0	25	25	100
Public institutions	98	0	0	0	2	0	100
Unknown	87	13	0	0	0	0	100
Total	88	3	1	*	5	3	100

*Negligible.

Tree Species

Use of the various species of Christmas trees depends to a great extent on availability, quality, size and relative price. Another important determinant of volume of use is the uniqueness of a species. Tradition has much to do with the widespread preference for balsam fir and spruce. Many users of these species feel that no other species

is appropriate for a Christmas tree. Similarly, the newer Scotch pine enthusiasts frequently feel that Scotch pine is preferable to all other species, regardless of price. Other species such as Douglas fir and white spruce also have their strong supporters.

Nevertheless, uniqueness of a species is not nearly so important as a few years ago. Most consumers are willing to shift their allegiance, which is apparent from the rapid shifts that have been taking place in species use over the past decade.

Moreover, consumers reveal a common inability to recognize species. In the present study, no attempt was made by respondents to identify 30 percent of the trees. An additional 7 percent of the trees in the nonfamily market were identified in such vague or incorrect terms as needle pine, shortneedle pine, or long needle pine. Of the 63 percent of the trees which were identified by common names, an indeterminate number were probably identified incorrectly.

Trees given recognizable names by respondents are distributed by species as follows: Scotch pine, 44 percent; jack pine, 25 percent; spruce, 22 percent; balsam fir, 5 percent; Douglas fir, 3 percent; and red pine, 1 percent. There is no way to check the accuracy of this classification, but a comparison with the results of a 1956 survey of Christmas trees in Lansing retail yards shows some striking differences which can be explained only on the basis of incorrect classification.[2]

Tree Sizes

Christmas trees displayed in the nonfamily market are no larger, on the average, than those displayed in the home. The maximum room height in a home is usually 8 feet and this controls the maximum size of Christmas trees displayed. Christmas trees in some store lobbies could be much larger, but the fact is that they usually are not. Compare the distribution of tree sizes in the Lansing nonfamily market

[2]The survey of Lansing retail yards (results unpublished) which covered at least 90 percent of all trees offered for sale locally, showed jack pine to be a very minor species (only about 100 trees were offered for sale). Contrast this with the roughly 1,000 jack pines reported by respondents in the present study. A negligible number of red pine was reported in the present study, although the survey of retail yards showed red pine constituted 10 percent of all trees offered for sale. The difference in dates between the two surveys—1956 and 1957—cannot account for a large part of the apparent discrepancies.
The distribution of species in Lansing retail yards follows:

Species	*Percent of all trees*
Spruce	31
Scotch pine	30
Balsam fir	24
Red pine	10
Douglas fir	2
Jack pine	*
Other	3
	100

*Negligible.

TABLE 4—Sizes of Christmas trees displayed in the Lansing area by nonfamily users compared with sizes in retail yards

Height of trees	Nonfamily users	Retail yards
Feet	Percent	Percent
3 or less	10	5
4-6	60	65
7-9	23	25
10 or larger	7	5
Total	100	100

with the distribution of sizes in Lansing retail yards[3] (Table 4). The similarity in the distributions is striking.

Tree sizes in the nonfamily market vary considerably by kind of establishment (Table 5). The most popular size class for all kinds of establishments is 4-6 feet, but preferences in the other size classes differ greatly. Trees 10 feet or higher are confined mainly to retail stores and professional-service establishments. Small trees below 4 feet in height are scarce in retail stores and public institutions, but are used extensively in other kinds of establishments.

[3]The survey of the Lansing retail yards, made in 1956, included yards with at least 90 percent of the Christmas trees offered for sale in Lansing.

TABLE 5—Sizes of Christmas trees displayed by kind of establishment, 1957

Kind of establishment	Sizes of trees in feet				
	3 or less	4-6	7-9	10 or larger	All sizes
	(Percent)				
Stores	3	58	28	11	100
Professional services	25	56	6	13	100
General services	23	45	30	2	100
Miscellaneous sales outlets	15	50	35	0	100
Manufacturing plants	33	67	0	0	100
Public institutions	4	73	17	5	100
Unknown	12	63	25	0	100
Total	10	60	23	7	100

Tree sizes also vary by types of trees (Table 6). Untreated, natural trees, which predominate in the nonfamily market, fall into a size pattern similar to that for all types of trees combined. Painted trees are mainly 7 to 9 feet in size. Flocked trees are small (4 to 6 feet) or large (10 feet or more). Other types of trees—table model, balled and burlapped, and artificial—are concentrated in very small sizes.

TABLE 6—Sizes of Christmas trees displayed by type of tree, 1957

Type of tree	Sizes of trees in feet				
	3 or less	4-6	7-9	10 or larger	All sizes
	(Percent)				
Untreated, natural	4	66	23	7	100
Painted	25	0	75	0	100
Flocked	0	60	0	40	100
Balled and burlapped	100	0	0	0	100
Table model	95	5	0	0	100
Artificial	80	20	0	0	100
Total	10	60	23	7	100

Tree Quality

No direct measure of tree quality in the nonfamily Christmas tree market is available. However, an indirect indication of some aspects of quality can be gained from data on tree locations in establishments. Trees located in the center of a room or near a window require good form when seen from all sides. Trees placed outside, in full view of passersby, also require good form. Thus, it is probably a good reflection of tree quality in the nonfamily market to observe that 16 percent of the trees are displayed in the center of a room; 44 percent, near windows; and 10 percent, outside. Only 30 percent of the trees are located at the side or in corners of rooms, locations which permit some departures from symmetrical form.

The preponderance of locations requiring good tree form suggests that quality in the nonfamily market is better than in the family market.[4] This conclusion is reinforced by the comparison of prices

[4]James, Lee M. (1957). Resurvey of Christmas Tree Maketing in Michigan. Mich. Agr. Expt. Sta. Spec. Bul. 419. 42 pp.
Some 6,000 trees were graded in retail yards throughout Michigan. Three acceptable grades were recognized—premium, standard, and utility—based on tree density, taper, balance, foliage, and deformities. Fifteen percent of the trees were classified as premium, 35 percent standard, 45 percent utility, and 5 percent cull.

paid by nonfamily consumers with prices paid by all consumers. (Price data will be examined in a subsequent section of this report.)

Tree locations vary by kind of establishment (Table 7). All categories of establishments, with the exception of manufacturing plants, place a majority of their trees in locations requiring good quality trees; but the patterns vary in details. Retail stores use the highest quality-demanding locations-only 6 percent of the trees displayed are at the side or corners of rooms.

TABLE 7—Location of Christmas trees displayed[1] by kind of establishment, 1957

Kind of establishment	Location in room					
	Center	Side	Corner	Near window	Outside	All locations
	(Percent)					
Stores	4	1	5	69	21	100
Professional services	10	23	17	43	7	100
General services	7	14	19	51	9	100
Miscellaneous sales outlets	6	5	35	47	7	100
Manufacturing plants	33	0	67	0	0	100
Public institutions	38	31	16	15	0	100
Unknown	25	38	12	25	0	100
Total	16	16	14	44	10	100

[1] Table model trees not included.

Source of Trees

About 54 percent of the trees used in the nonfamily market are purchased at retail yards; 6 percent from wholesalers; 33 percent from tree growers; and 7 percent are acquired from other sources.

Retailers are the primary source of trees. This is not surprising, since retail lots are readily available and the most commonly used kinds and types of trees are available from retailers. Relatively few trees are bought from wholesalers, since only a few users are interested in acquiring wholesale lots of trees.

What does appear surprising at first glance is the large amount of direct purchase from tree growers. Several explanations can be offered: (1) Stores which retail trees or lease sites to growers for the retailing of trees have the necessary contacts with growers for the display trees they need. (2) Establishments with specialized tree

requirements may not be able to rely on retail lots; they may find it advisable to establish their own grower contacts for special tree purchases. (3) More than half the trees obtained from growers are bought for early displays prior to December, at a time when a very small number of trees is available for sale in retail lots.

Time of Purchase

Nonfamily users interested in early Christmas tree displays need to turn for their trees to growers and other sources outside the regular wholesaler-retailer channels. This is a large group of users, but much smaller than the group of nonfamily users which delays its Christmas tree acquisitions until December (Table 8). Some 52 percent of the trees used by the nonfamily market are acquired in the period December 1-15; 20 percent are obtained earlier; and 28 percent later.

TABLE 8—Source of Christmas tree acquisitions by time period, 1957

	Source of trees				
	Retailer	Wholesaler	Tree grower	Other	All sources
	(Percent)				
Before Nov. 15....	0	0	7	2	2
Nov. 16-30.....	2	0	52	18	18
Dec. 1-15.....	68	80	19	52	52
Dec. 16 or later...	30	20	22	28	28
Total.....	100	100	100	100	100

Tree Prices

Average prices of untreated, natural trees purchased from retailers are shown in Table 9. Prices increase steadily with tree size. They also differ by species. Because of the weak identification of species by respondents in this study, one cannot attach great accuracy to the averages for individual species. Nevertheless, the general pattern is probably correct; it follows the pattern shown in other studies where species were properly identified.[5] Douglas fir is the highest-priced species, followed by Scotch pine, spruce, and all other.

Average prices in the nonfamily market are higher than the prices

[5]James, Lee M. Op. cit.

TABLE 9—Average prices of specified species of untreated natural Christmas trees purchased from retailers, by tree size, 1957

Size of trees	Scotch pine	Spruce	Douglas fir	Other	All species[1]
Feet	Dollars	Dollars	Dollars	Dollars	Dollars
3 or less.....	2.25	2.00	....	....	2.20
4-6.....	3.50	3.00	4.50	3.00	3.40
7-9.....	6.00	4.00	7.00	3.50	4.50
10 or larger.....	12.00	8.00	13.00	....	12.00
Total.....	4.50	4.50	8.25	3.25	4.00

[1]Includes all prices reported regardless of species.

reported in the 1956 study of Michigan retail yards.[6] Prices in the two studies are not directly comparable, but adjustments can be made in the comparison for the different bases. Some slight price increases in Christmas trees occurred between 1956 and 1957. The nonfamily market prices are for Lansing and the retail-yard prices are statewide; yet the likelihood is that Lansing prices are representative of statewide nonfamily market prices. (In the 1956 study, it was found that Lansing retail prices were higher than small city prices, but lower than Detroit prices.) Average prices in the retail market are weighted somewhat (and presumably, upwards) by the inclusion of purchases by nonfamily users. Considering all factors, the actual differences between nonfamily market prices and family market prices are probably much the same as those shown in the following comparison:

Average retail prices in —

	Nonfamily market Michigan	Total market Michigan
Scotch pine	$4.50	$4.00
Spruce	4.50	3.00
Douglas fir	8.25	5.50
Other	3.25	3.00
Total	4.00	3.25

Higher prices in the nonfamily market than in the family market reflect the higher tree quality demands of the nonfamily market. (See section on Tree Quality.)

[6]Ibid.

Maximum retail prices in the nonfamily market are shown in Table 10. Maximum prices are often considerably higher than average prices. It is noteworthy that maximum price in each size class is for a tree of undesignated species. Consumer preferences for particular species exist, but it is apparent that many nonfamily users are guided more by the appearance of a tree than by the notion of inherent superiority implied in a particular species name.

TABLE 10—Maximum prices of specified species of untreated natural Christmas trees purchased from retailers, by tree size, 1957

Size of trees	Scotch pine	Spruce	Douglas fir	Other	All species[1]
Feet	Dollars	Dollars	Dollars	Dollars	Dollars
3 or less	2.75	2.00	....	....	3.00
4-6	4.50	4.00	4.74	3.50	5.50
7-9	8.00	5.00	8.50	4.00	9.00
10 or larger	12.50	10.00	14.00	25.00	25.00

[1] Includes all prices reported regardless of species. Maximum price in each size class is for a tree of unidentified species.

Prices reported above are retail prices. Wholesale prices are presumably slightly lower, but wholesale prices reported were too few to justify their summarization. Trees purchased directly from growers (about a third of all nonfamily tree purchases) are generally 50 to 75 cents cheaper than trees purchased from retailers.

Modifying natural trees by painting or flocking adds substantially to tree prices. In general, painting adds about 50 cents to the price for each foot of height[7], although in this study the addition was about 35 cents for trees in the 4-6 foot height range. Retail prices for painted trees average $5.00 for 4-6 foot trees and $8.50 for 7-9 foot trees. Flocking is a much more expensive process. Average retail prices for flocked trees of various sizes are as follows: 4-6 feet, $10; 7-9 feet, $20; 10 feet or more, $30.

Artificial trees are not yet price-competitive with natural trees. At retail, artificial-tree prices average $3 for trees 3 feet or smaller in size and $10 for trees in the 4 to 6-foot size range. The appeal of artificial trees rests on their novelty and long life, not on purchase price.

[7] Ibid.

SUMMARY

The Lansing nonfamily market for Christmas trees used an estimated 6,135 trees in 1957, equivalent to 1 tree per 19.5 persons of total population. A comparison with results of a 1956 survey of the family market in Lansing indicates that nonfamily use accounts for 19 percent of all Christmas tree consumption.

One-fourth of the establishments listed in the yellow pages of the Lansing telephone directory displayed at least one Christmas tree. Most establishments had only one tree, but the average is 2.55 trees for all establishments displaying trees. Public institutions, mainly the public schools, account for 32 percent of the total number of nonfamily trees; retail stores, 31 percent.

The most popular type of tree is still the untreated, natural tree—88 percent of the total. Painted trees make up 3 percent of the total; flocked trees, 1 percent; table model trees, 5 percent; and artificial trees, 3 percent.

Scotch pine and various spruces are apparently among the most popular species used, although a correct classification of species cannot be made from the returns of this survey. Respondents to the mail questionnaire made no attempt to identify 30 percent of the trees; 7 percent of the trees were identified in vague or inexact terms; and other mistakes in classification were obvious. Consumer preferences for particular species exist, but it is apparent that many nonfamily users are guided in their purchases more by the appearance of a Christmas tree than by the name it bears.

Christmas trees displayed are usually no larger than those bought for home use. Only 7 percent of the trees in the nonfamily market are above 9 feet in height. The most popular tree heights are from 4 to 6 feet.

Nonfamily users display most trees in locations requiring good tree form. Only 30 percent are located at the side or in corners of rooms, locations which permit some departures from symmetrical form.

Retailers are the primary sources of trees, but 33 percent of the trees are obtained directly from tree growers. More than half the trees obtained from growers are bought for early displays prior to December, at a time when very few trees are available for sale in retail lots.

Tree prices vary by species, size, quality, type of tree, and point of purchase. In general, retail prices for untreated, natural trees are higher than in the family market, a reflection of the demand for higher tree quality in the nonfamily market.

FAMILY PURCHASES OF CHRISTMAS TREES IN LANSING, MICHIGAN

By LEE M. JAMES

DEPARTMENT OF FORESTRY

THIS ARTICLE SUMMARIZES findings of a study made during the 1956 Christmas season in Lansing, Michigan, as one phase of a broad regional project in Christmas tree marketing.[1] It is concerned mainly with the extent of family use of Christmas trees, the timing of tree purchases, and the kinds of trees used.

The study is based mainly on a telephone survey of 300 home listings selected from the Lansing telephone directory, roughly a 1 percent sampling of the total population of home listings. Listings were drawn systematically from the directory to provide complete alphabetical coverage. Interviews were standardized and data were recorded on prepared forms.

Families Surveyed

The 300 family units covered in the survey ranged from 1 to 10 members, distributed as follows:

Persons in family Number	*Family units sampled as percentage of total sample*
1	6
2	26
3	18
4	26
5	10
6	8
7 or more	6
Total	100

The total population included in the sample was 1,080, and the average family unit included 3.6 persons.

[1]NCM-20, the cooperative regional research Project on Christmas tree marketing, is under the supervision of the North Central Regional Technical Committee, in which the Michigan Agricultural Experiment Station participates. The project is largely supported by regional research funds provided under federal acts authorizing cooperative research by state agricultural experiment stations.

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Number of Trees Used

Family units sampled displayed 236 Christmas trees of all kinds, or an average of one tree per 4.6 persons. [This is a much higher ratio of consumption to population than exists for nonfamily use. A 1957 study in the Lansing area shows nonfamily use of Christmas trees to average one tree per 19.5 persons.[2]] Thus, family use makes up 81 percent of all Christmas tree consumption in the area.

Seventy-eight percent of the family units display Christmas trees. This is a statistic greatly influenced by size of family (Table 1). All large families sampled (7 or more members) displayed a Christmas tree. The percentage drops very slowly with smaller families down to 3-person units, below which point a sharp change in Christmas tree use occurs. Only 49 percent of the 2-person family units and 29 percent of the 1-person family units have Christmas trees.

TABLE 1—Use of Christmas trees by size of family unit, 1956

Persons in family	Family units without a Christmas tree	Family units with a Christmas tree	Ratio of persons to Christmas trees
Number	Percent	Percent	
1	71	29	3.4
2	51	49	3.9
3	9	91	3.3
4	8	92	4.2
5	7	93	5.4
6	4	96	6.2
7 or more...	0	100	7.6
Total.....	22	78	4.6

Despite the common absence of trees among very small family units, the volume of consumption per unit of population is higher than among the larger family units. One-person family units use 1 tree per 3.4 persons in contrast to 1 tree per 7.6 persons among family units with more than 6 members.

Only 2 percent of the families with trees display more than one tree. This fact points up the present inflexibility of the Christmas tree market — demand is geared to population. Somewhat more than

[2]Manuscript in preparation for the Michigan Agricultural Experiment Station Quarterly Bulletin under the title "The nonfamily market for Christmas trees in Lansing, Michigan."

three-fourths of the family units display Christmas trees, but rarely more than one tree. Small price changes can have little effect on this volume of use.

Method of Acquisition

Purchase, mainly in retail yards, is the principal means of obtaining Christmas trees for home use. Five percent of the families reporting Christmas trees in their homes obtained their trees as gifts; 2 percent stated they obtained trees from their own properties. All other families reported purchasing their trees.

Time of Purchase

Christmas tree purchases for home use were confined to the month of December in 1956 (Fig. 1). One consumer in the sample purchased

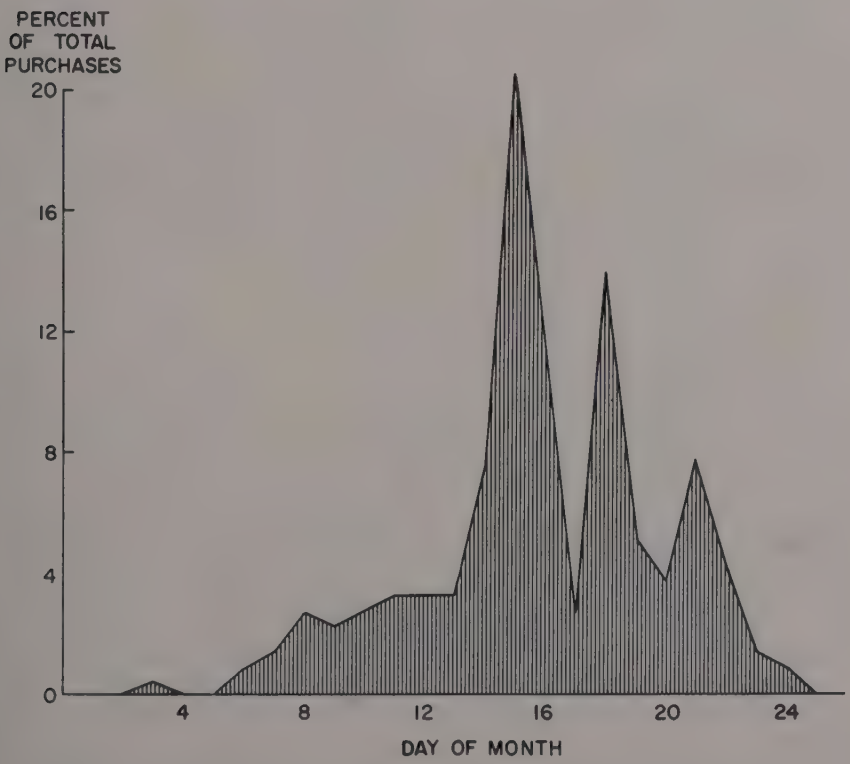

Fig. 1. Christmas tree purchases by day of month, December 1956.

a tree on Dec. 3, and no further purchases occurred until Dec. 6. The last purchases took place on Dec. 24, the day before Christmas.

Only 3 percent of the trees were purchased during the first week ending Dec. 7. Twenty-five percent of the trees were purchased in the second week; 65 percent in the third week; and 7 percent in the 3-day period preceding Christmas Day. This is a different pattern than that determined in Columbus, Ohio, by Mitchell and Quigley.[3]

Purchases by sales days are shown in Fig. 2. The importance of different sales days is seen to vary from week to week depending on length of time to Christmas Day. Friday was the most active sales day in the first two weeks, but on the one Saturday beginning the

[3]Mitchell, G. H. and Kenneth Quigley (1958). Christmas tree purchasing habits of Greater Columbus, Ohio, consumers—1956. Ohio Agr. Expt. Sta. Mimeo. Series A. E. 287. 10 pp.
The Columbus, Ohio, study, which was conducted like the Lansing study, showed about 8 percent of the Christmas tree purchases occurred from Dec. 1 to Dec. 13. Thereafter, purchases built up steadily to a daily peak of 17 percent on Dec. 22.

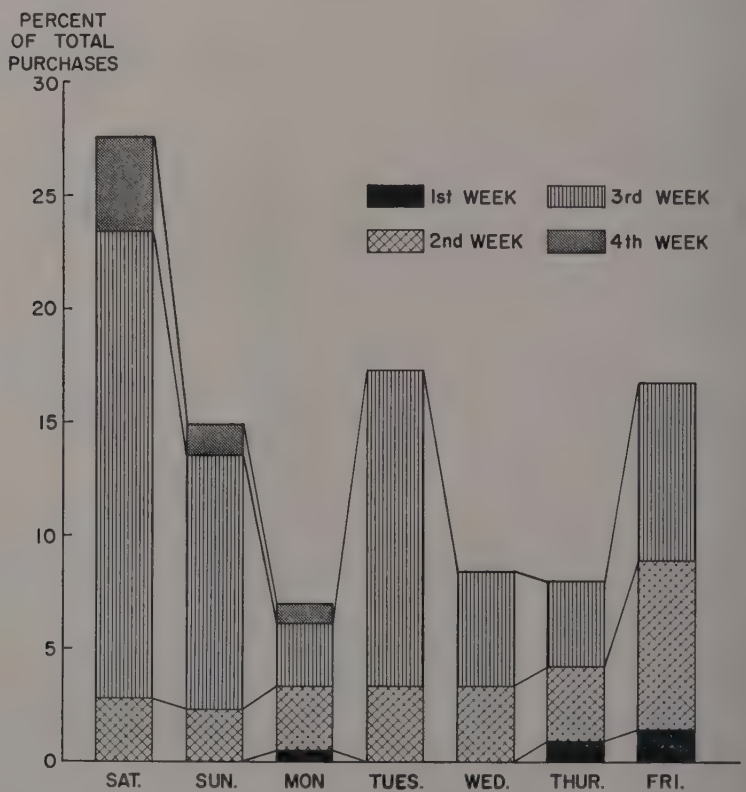

Fig. 2. Christmas tree purchases by day of week, December 1956. (Fourth-week sales 3 days only. Tuesday was Christmas Day.)

third week nearly 21 percent of all trees were purchased. Sunday and Tuesday sales in the third week also surpassed Friday sales. Based on cumulative totals for each week day, the busiest sales periods are weekends from Friday through Sunday, with Saturday as the most active single sales day. Sales fell off during middle-of-the-week periods with the notable exception of Tuesday.

Except for the Tuesday rise in sales, the Lansing pattern of purchases by sales days is similar to the pattern determined in the Columbus, Ohio, study.[4]

Types of Trees

Ninety-five percent of all trees displayed in the Lansing family market are natural, untreated trees. Painted trees (including painted table model trees) comprise only 1 percent of the total, a surprisingly low figure. Artificial trees make up 4 percent of the total.

Artificial trees have been increasing in use, but still offer little competition to natural trees. Their disadvantages of appearance, high price, and storage problems have restricted their acceptance almost entirely to a small segment of the 1- and 2-member family units.

The family market in Lansing leans more heavily on natural, untreated trees than does the nonfamily market, although the general patterns of use are similar. Nine percent of the trees in the non-family market are modified, natural types, and 3 percent are artificial.[5]

Species of Trees

Some consumers have strong species preferences, but they are a minority. It is apparent from results of the telephone survey that most consumers are unaware of species distinctions and do not know what species they have selected for home use.

To determine species use in the Lansing family market, it was necessary to drop the telephone survey of consumers and to rely on unpublished data from a survey of Lansing retail yards conducted during the 1956 season.[6] The latter survey covered at least 90 percent of all trees offered for sale locally. Since 81 percent of total consumption is for family use, species distribution in retail yards is a good indication of species use in homes.

[4]Ibid.

[5]Manuscript in preparation previously cited.

[6]Data collected as part of a statewide study of Christmas tree retail yards. For statewide study, see James, Lee M. (1957). Resurvey of Christmas tree marketing in Michigan, Mich. Agr. Expt. Sta. Spec. Bul. 419. 42 pp.

The distribution of species in Lansing retail yards follows:

Species	*Percent of all trees*
Scotch pine	30
Balsam fir	24
White spruce	19
Red pine	10
Black spruce	8
Norway spruce	4
Douglas fir	2
Other	3
Total	100

Plantation trees have been gaining rapidly at the expense of wild trees. In 1952, the majority of trees used in Lansing homes were wild trees,[7] but by 1956, at least 60 percent of the total were plantation trees. Such changes in use are affected more by appearance, size and relative price of trees available in the market than by consumer preferences for particular species.

Tree Sizes

Tree sizes in the Lansing family market are best revealed by the previously cited 1956 survey of Lansing retail yards. Unpublished data from this detailed survey indicate the following distribution of tree sizes:

Height in feet	*Percent of all trees*
3	5
4	10
5	30
6	25
7	15
8	9
9-11	7
Over 11	3
Total	100

The most popular tree sizes are 5- and 6-foot trees. These results correspond generally to the tree-size preferences revealed by the statewide survey of retail yards.[8]

[7]Unpublished data from 1952 survey of Lansing retail yards.

[8]James. Op. cit.

Distribution of tree sizes in the statewide study follows:

Height in feet	*Percent of all trees*
4 and less	10
5-6	50
7-8	30
9 and more	10
Total	100

The maximum height for trees in the home is usually 8 feet. Ten percent of the trees purchased are larger, but consumers are frequently willing to buy larger trees and cut them back to desired sizes. Better quality trees are often obtained in this way.

Tree Quality

Since 4 out of every 5 trees in Lansing retail yards are destined for home use, the quality of trees in retail yards is indicative of the quality of trees in the family market. The appraisal of tree quality presented here is based on a sample of some 2,000 trees — roughly 50 trees in each of 40 Lansing retail lots.

Ten percent of the trees were classed as premium, 35 percent standard, 50 percent utility, and 5 percent cull.[9] Since utility grade represents the minimum acceptable, quality can only be appraised as disproportionately low-grade. However, tree grades in Lansing retail yards are very similar to those found throughout Michigan retail yards.[10]

The variation in quality by species is shown in Table 2. Some of the variation among species is inherent in growth characteristics, but much of it is due to the degree to which management is applied — shearing and shaping, spraying, and other features of plantation management. Tree grades are poorest in balsam fir (wild-grown) and red pine (plantation-grown). Quality is best in Douglas fir and plantation-grown spruces.

[9]Three acceptable grades were recognized in this 1956 survey—premium, standard and utility—based on tree density, taper, balance, foliage and deformities.

[10]James. Op. cit.
In retail yards throughout Michigan, 15 percent of the trees were classed as premium, 35 percent standard, 45 percent utility, and 5 percent cull.

TABLE 2—Quality of trees in Lansing retail yards, by species, 1956

Species	Premium	Standard	Utility	Cull	All grades
	Percent	Percent	Percent	Percent	Percent
Scotch pine	10	40	40	10	100
Balsam fir	*	30	60	10	100
Red pine	5	30	60	5	100
White spruce	20	45	35	*	100
Black spruce	10	35	50	5	100
Norway spruce	25	45	30	*	100
Douglas fir	25	60	15	*	100
Other	10	40	40	10	100
Total	10	35	50	5	100

*Negligible.

SUMMARY

The family market in Lansing used one Christmas tree per 4.6 persons in 1956, or a total of 21,740 trees per 100,000 of population. This represents 81 percent of all Christmas tree consumption in the Lansing area.

Seventy-eight percent of all family units display Christmas trees. The proportion of family units displaying Christmas trees is much smaller among 1- and 2-member families than among larger families, but the ratio of trees to population is higher among the small families.

Ninety-eight percent of the families displaying Christmas trees limit themselves to a single tree. Ninety-five percent of all trees displayed are natural, untreated trees. Painted trees comprise 1 percent of the total; artificial trees, 4 percent.

Christmas tree purchases for home use in 1956 were confined to the month of December. Three percent of the trees were purchased during the first week ending Dec. 7, 25 percent in the second week, 65 percent in the third week, and 7 percent in the 3-day period preceding Christmas Day. Saturday, Dec. 15, was the busiest single sales day.

Few consumers know what species of tree they have selected, but tree inventories in Lansing retail yards indicate that about 60 percent of the trees used are plantation-grown—mainly Scotch pine, white spruce and red pine. Inventories in retail yards also show that the most widely used tree heights are 5 and 6 feet, and that tree quality tends to be low.

A LABORATORY METHOD FOR TESTING THE ACCURACY OF THE MILK-O-METER

By E. W. HUPP and W. W. SNYDER

INTRODUCTION

THE INCREASING USE of pipeline milking systems has created an urgent need for a simple and accurate milk weighing device that can be incorporated into the system. The Milk-o-Meter is one device which has been manufactured to meet this need. The results of earlier tests on the accuracy of the Milk-o-Meter have been reported in a previous publication[1]. Those tests were conducted under barn conditions by milking cows and weighing the milk. That procedure is not practical for checking the accuracy of the meter daily or several times each month.

During the past year it became apparent to the authors that the Milk-o-Meter must be checked for accuracy at regular intervals. This present report deals with a new laboratory method developed at this station for testing the accuracy of the meter. A factory approved method was also evaluated and will be reported. The meters used for testing purposes had been in constant use for 10 months or longer. Thus, this report also gives the laboratory results of our tests for accuracy of these meters. The results for certain modifications of the meter will also be reported.

EXPERIMENTAL PROCEDURE

The flow apparatus which was constructed in this laboratory to deliver water to the meter consists of the following parts: A reservoir for the water, a glass tube with an opening of specific size to regulate

[1]Hupp, E. W., et al. (1957) The accuracy of a milk metering device. Michigan Quarterly Bulletin 40: 365.

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the rate of flow, an air inlet into the hose leading from the reservoir to the meter, a mounting bracket for the meter, a milker pail to receive the water from the meter, and a source of vacuum.

The reservoir of the apparatus has a valve at the bottom which is used to turn the water on and off at the beginning and end of each run. The air inlet into the system between the reservoir and the meter is provided so that the water goes into the meter in a manner similar to the flow of milk from the cow. Four glass tubes drawn to varying sizes of openings were used. One of these four glass tubes was inserted into the hose between the water reservoir and the Milk-o-Meter to obtain 1 of the 4 rates of flow.

The rate of flow and the standard deviation for each of these tubes was 2.9 plus or minus 0.15, 5.2 plus or minus 0.20, 7.2 plus or minus 0.27, and 11.5 plus or minus 0.59 pounds per minute. The variation in rate of flow was primarily due to the fluctuations in the vacuum level. It is possible that these variations could have some effect on the error at each rate of flow from trial to trial, however, this effect was not very large as indicated by the relatively small standard deviations.

The Milk-o-Meters were tested on the flow device by running the water through the meter for a fixed period of time for each rate of flow. The meter reading was recorded for each run. The weigh pan was tripped and the amount of water which was in the weigh pan was measured in the calibrated hose leading to the milker bucket. This amount was added to the meter reading to obtain the total amount of water recorded by the meter.

The amount of water that had passed through the meter and into the milker pail was weighed on either a Dayton Platform Scale, the accuracy of which had been verified, or in a few cases a spring scale, the accuracy of which had been checked. The percent error for each run was calculated by subtracting the scale weight from the meter weight and dividing the difference by the scale weight.

The factory recommended method for testing the Milk-o-Meter was also used in this study. The procedure is as follows: Place the Milk-o-Meter on the pipe clamp bracket and make sure the meter is level. Then install the lower shell and weigh tray leaving the upper shell and baffle system removed. Pour water on both sides of the weigh tray, then trip to drain naturally. Use a standard volumetric pipette graduated to deliver 125 ml., or a 100 ml. volumetric flask plus a

Fig. 1. The laboratory apparatus used for testing the accuracy of the Milk-o-Meter at various rates of flow. The hose leading from the 10-gallon can to the Milk-o-Meter contains the glass tube for controlling the rate of flow. The milker pail is used to hold all of the water recorded by the meter for a specific test trial. The system is controlled by applying vacuum to the milker pail.

25 ml. graduated pipette, to fill one side of the weigh tray and note the exact number of milliliters of water required to trip the weigh tray.

Repeat this procedure for the other side. The total amount of water required to trip the two sides of the tray should be between 218 and 230 mls. If the total is outside these limits, the meter should be returned to the factory for recalibration. These instructions were followed except that meters which did not meet the specifications were recalibrated in this laboratory.

Six different meters were tested in Part 1 of this experiment. Five of these were of the type available commercially at the time of testing and had the upper distribution tray with a rib to hold the tray in place. They will be referred to as the "LMB" model, which is the manufacturer's code.

Four of the meters had been in continuous operation for 10 months or longer. They had been used in milking 50-70 cows twice

daily in the Michigan State University main stanchion barn. The fifth meter was used as a spare; however, the meters were rotated so all received approximately equal service. The sixth meter was designed for experimental purposes so that it could be used with a recorder. The meter parts and weighing device were the same as for the other meters. This recording meter had seen only limited use.

The meters were brought in from the barn, one or two at a time, and tested by the factory recommended procedure. They were tested twice and the mean of these two observations used as the total capacity of the weigh tray. They were then tested twice at each of the 4 rates of flow on the flow-testing device. Due to the lack of time and the necessity for using the meters, they were returned to service following testing.

Several days later one meter at a time was again brought in from the barn and the dial and face removed in order to properly clean all parts. The clutches on two of the meters were too tight and these were oiled or loosened to allow proper operation. The accessible parts of the meter were also lightly oiled.

Next it was determined whether the weigh pan on both sides of the meter came to the same level when the pan was in a position to be filled. It was found that in most cases, they did not come to the same level. In one case the shaft allowed the weigh pan to rock which was prevented by slightly springing the shaft.

Two other shafts did not hold the pan at the proper level on each side. These shafts were far enough out of alignment so that the pan could not be leveled by rotating or interchanging the weigh pans. The shaft from one meter (the recording meter) was substituted for the shaft of the meter being tested whenever it was impossible to get the weigh pan properly adjusted with the regular shaft for that meter.

The number of milliliters of water held by both sides of the pan was determined by using a weigh pan and shaft combination which allowed the pan to come to the same level on both sides. One meter required no adjustment. The other meters were adjusted until the total amount of water held by the 2 weigh pans was approximately equal and was within the factory required limits.

Following this adjustment each meter was tested five times and if these five values averaged within the above limits, the meter was moved over to the flow testing device and checked for accuracy twice at each of the four rates of flow. The recording meter was tested five times at each of the four rates of flow, rather than twice.

In Part 2, combinations of three different types of distribution trays and two types of weigh trays were tested. Two meters were used. One was a new meter with the modified weigh tray. The other was the recording meter using a standard weigh tray. The accuracy of the five different combinations at the 4 rates of flow were compared for accuracy.

RESULTS AND DISCUSSION

Part 1 Accuracy of the meters before and after adjustment.

The results of tests for accuracy of the 6 meters before and after adjustment are reported in Table 1 and Table 2. The results in Table 1 show that after 10 months of operation, four of the five meters tested did not meet the specified limits when tested by the factory recommended method. A comparison with the results in Table 2 shows that the accuracy of three of these meters was not satisfactory at 1 or more of the rates of flow. The recording meter was inaccurate after only a short period of use.

TABLE 1—The volume of water held by the two sides of the weigh tray for each of six Milk-o-Meters before and after adjustment

Factory meter No.	Before adjustment			After adjustment		
	Left side	Right side	Total Vol.	Left side	Right side	Total Vol.
	ml.	ml.	ml.	ml.	ml.	ml.
1-1558.....	93.4	123.3	216.7	113.4	111.5	224.9
1-1553.....	107.3	121.4	228.7	.....	.....	.....
1-1460.....	113.6	100.0	213.6	111.6	113.0	224.6
1-1559.....	110.6	103.8	214.4	111.6	108.4	220.0
1-1454.....	112.5	98.1	210.6	109.8	111.3	221.1
1-2300(R)..	115.4	117.8	232.4	109.2	109.3	218.5

Several factors may have contributed to the inaccuracy of these meters. There was some rotation of parts between meters, since these parts were not kept separate during the daily cleaning. A meter which may have had acceptable accuracy, had it been operated with the parts with which it was calibrated, may have been inaccurate with the parts used when it was tested.

This would not be a problem if only one meter was used. These meters had been subjected to heavy use on many cows at each milk-

ing. This is more wear than would be encountered in most herds or if used for a few herds on test day for weighing and sampling the milk.

After proper adjustment acceptable accuracy on the flow tests was obtained, except for one meter which was quite inaccurate at the fastest rate of flow.

These results indicate that the factory recommended method for testing accuracy is an acceptable, practical, and very simple method. This method is recommended for checking the accuracy of the Milk-o-Meters by Dairy Herd Improvement Association supervisors and others. The fact that 5 of 6 meters were out of adjustment indicates that a method for checking the accuracy is needed.

Several other points are related to the accuracy of the meter. The two sides of the meter should hold approximately the same amount of water, probably within 10 to 15 ml. of each other. This will avoid the possibility of the side holding the most milk (during actual milking) running over before tripping. The two sides of the tray should

TABLE 2—The percentage error for six Milk-o-Meters at four rates of flow before and after adjustment

Factory meter No.	Rate of flow in pounds per minute				Mean error	Mean bias
	2.9	5.2	7.2	11.5		
	Percent	Percent	Percent	Percent	Percent	Percent
Before Adjustment						
1-1558	−1.4	−1.3	−3.6	−8.0	3.6	−3.6
1-1553	−0.1	+0.6	−1.0	−3.6	1.3	−1.0
1-1460	+2.7	+1.7	−0.3	+0.8	1.4	−1.0
1-1559	+5.7	+3.4	+3.1	+0.9	3.3	+3.3
1-1454	+3.0	+0.4	−0.5	+1.6	1.4	+1.1
1-2300(a)	−5.3	−5.8	−6.4	−9.1	6.6	−6.6
				Ave.	2.9	2.8
After adjustment						
1-1558	−0.3	+0.1	−1.5	−8.2	2.5	−2.5
1-1553	Not adjusted					
1-1460(b)	+2.6	+2.0	−0.6	−1.1	1.6	−0.8
1-1559	+1.0	+0.2	−1.3	−1.6	1.0	−0.4
1-1454	+2.0	+2.0	+1.7	−1.6	1.8	−1.0
1-2300(a)	+0.8	−1.6	−2.5	−3.3	2.0	−1.7
				Ave.	1.8	1.3

(*a*) Recording meter.
(*b*) Pointer may have slipped, giving a positive error.

rise to approximately the same level when filling or the side which is too low may run over before tripping.

Shafts or weigh trays which do not allow the meter to meet these additional requirements should not be used. During these experiments it was observed that the water must not be dropped from the pipette too slowly or the drops of water may set up a vibration and cause the pan to trip too soon. This would indicate that the meter was out of adjustment when this was not actually the case.

In evaluating the percentage error in Table 2, it should be pointed out that these errors do not correspond directly to those which might be expected under milking conditions. These values were obtained under optimum conditions and do not include errors which may result from vibration, improper leveling of the meter, bursts of air, or other factors. On the other hand, these values are obtained at a constant rate of flow, while that of the individual cow varies.

A period early in milking and during stripping will be at a slow rate while the middle period will be at a faster rate. Thus, in meters which have a positive error at the slow rate of flow and a negative error at faster rates, there will be some compensation which will reduce the net errors. Few cows will have an average rate of flow as slow as 3 pounds per minute, and none would be expected as high as 11.5 pounds per minute. A few cows will exceed the high rate during the peak rate of flow. Thus, an error in excess of 3 percent at the 11.5 pound per minute flow rate should not be considered disqualifying.

Part 2 Accuracy when using different combinations of meter parts.

Three different types of baffle plates were tested. One was the type in which a pin is used to hold the baffle plate in the upper shell. This type is no longer available commercially. The standard type, known as the "LMB" model and an experimental baffle plate in which "V" shaped slots replaced the regular round holes were also tested.

Two types of weigh pans were tested. One was the standard model at the time of testing and the other a modified model which became standard equipment on new meters after July 1, 1958. It has slightly more capacity and also has a rib on each side next to the divider.

The accuracy of the combinations of these parts at the four rates of flow is presented in Table 3. These results show that combination 2, using the "LMB" upper baffle plate and the modified weigh pan, has the least bias error caused by the rate of flow.

TABLE 3—The percentage error for five different combinations of Milk-o-Meter parts at four rates of flow

Combination of parts(*a*)	Total No. of observations(*b*)	Rate of flow in pounds per minute			
		2.9	5.2	7.2	11.5
		Percent	Percent	Percent	Percent
1	32	+0.44	−1.38	−2.51	−3.64
2	16	+0.56	−0.97	−1.36	−0.94
3	8	+1.44	−0.08	−1.88	−1.72
4	8	+0.64	+0.22	+0.02	−2.00
5	8	+0.16	−1.29	−4.32	−5.75

(*a*) Combination 1—LMB baffle plate and standard weigh pan.
Combination 2—LMB baffle plate and modified weigh pan.
Combination 3—Pin type baffle plate and modified weigh pan.
Combination 4—Pin type baffle plate and standard weigh pan.
Combination 5—Experimental baffle plate and modified weigh pan.
(*b*) Total number of observations for the combinations listed.

It was found that somewhat less water was required to trip the modified type weigh pan, when the meter was of the same adjustment, than the standard weigh pan. The new meter, which was calibrated with the modified weigh pan to hold an average of 220.7 mls., held an average of 225.0 mls. on the standard weigh pan.

The recording meter which was calibrated with the standard weigh pan at 226.2 mls., held only 221.1 mls. on the modified weigh pan. This is a mean difference of 4.7 mls. between the two types of weigh pans. However, as the two meters were calibrated, all observations fell within the limits of 218 to 230 mls. and the accuracy using either type of weigh pan was acceptable.

The effect of rotation of the weigh pans, or use of different weigh pans of the same type with the same meter was also investigated. This rotation of weigh pans caused differences in the amount of water held by each side, but the total held by both sides varied only slightly.

Apparently the variation is due to some lack of uniformity of the weigh pans and rocker shafts. The weigh pan may not rise to the same level on both sides and the side which rises to the highest level holds the most water, but the low side holds a compensating smaller amount. Small fluctuations in the amount held by each side should not cause serious error.

SUMMARY

A new laboratory method for testing the accuracy of the Milk-o-Meter is described. A simple factory recommended method was investigated and found to be practical and acceptable for field use.

After 10 months of use four or five meters did not meet the specified limits for accuracy when tested by the factory recommended method. The performance of three of the four meters was also unsatisfactory when tested at four controlled rates of flow. A recording meter which had seen only limited use was also found to be inaccurate. Following recalibration, so that they met the factory recommended limits, these meters also had acceptable accuracy when tested on the new flow device. These results indicate that the meters require periodic and regular checks for accuracy.

Various combinations of meter parts were tested. The "LMB" upper baffle plate and the modified weigh tray which became standard equipment on new meters after July 1, 1958, were found to yield the least bias error due to rate of flow. The slightly greater capacity of the modified weigh tray should reduce the chance of the weigh tray running over under actual milking conditions. For these reasons it is recommended that the modified weigh tray be used with all meters in preference to the previous standard weigh tray.

MICHIGAN BROILER TEST NO. 8

SPRING 1958[1]

By J. A. DAVIDSON, W. N. FISCHER and H. C. ZINDEL

DEPARTMENT OF POULTRY SCIENCE AND W. K. KELLOGG FARM

Purpose of Test

THIS WAS A DESCRIPTIVE TEST of varieties, strains, and strain crosses under environment and management conditions at the W. K. Kellogg Farm, Hickory Corners, Michigan.

Conditions of Test

The test was conducted on the ground floor of the two-story brooder house on the W. K. Kellogg Farm. Chicks were entered on April 17, 1958. One hundred and four chicks (52 pullets and 52 cockerels) were required for an entry (Table 1). Each entry was placed in a pen of equal floor space, (about 1 square foot per bird) which had been drawn by lot. (In an experiment conducted in 1957 using the same stock in all pens on the same feed, there was no pen position effect at 6 weeks of age.) Each chick was wing-banded for identification as well as a means of simplifying the withdrawal of a sample from which slaughtering data could be drawn.

If not debeaked when sent in, chicks were debeaked; they were then confined to a small area by a tight corral for 2 days. Heat was supplied by heat lamps which were discontinued as soon as possible during the day. Lights were used at night throughout the entire period.

Chicks were fed from a small feeder placed on paper. The paper was removed the second day. Large feeders were substituted for smaller feeders as the chicks grew. All feeders were of the same type for each pen. Small water fountains were used at first until the chicks were large enough to use automatic waterers. Sugar-cane was used as litter and some shavings were used the last few weeks.

[1]Sponsored by the Michigan Poultry and Hatchery Federation, East Lansing, Mich.

ARTICLE 41-57

TABLE 1—Entrants and breeding groups

Pen No.	Name	Male	Female
1	Cobb's Pedigreed Chicks..... Concord, Mass.	White Rock.....	White Rock
2	DeWitt Zeeland Hatchery..... Zeeland, Mich.	X-237	
3	DeWitt Zeeland Hatchery..... Zeeland, Mich.	X-238	
4	DeWitt Zeeland Hatchery..... Zeeland, Mich.	X-239	
5	Farm Service Center, Inc..... Orleans, Ind.	Peterson Dom. White.....	Arbor Acres White Rock
6	Hubbard Farms, Inc..... Walpole, N. H.	Wh. Mountain 978.....	43
7	Farm Service Center, Inc..... Orleans, Ind.	Chas. Vantress Dom White	Arbor Acres White Rock
8	Klager Hatcheries..... Bridgewater, Mich.	W-12.....	Klager Pilch

Disease Control

A coccidiostat (Nicarbazin) was used in the feed throughout the first 7 weeks of the test. At 10 days the chicks were vaccinated by the water method against bronchitis. At 3 weeks they were vaccinated by the water method against Newcastle disease. Reaction to vaccination did not seem to be severe in any of the groups.

Weighing and Scoring

At 4 weeks and again at 7 weeks, each entry was group-weighed and the following information was obtained for the benefit of the breeder or hatchery: Average live weight, feed consumed, and number in each pen.

At 9 weeks of age, the birds were individually weighed, checked for sex, and a random sample of 10 of each sex was taken for slaughtering (Table 2). The mean weight of the males and females along with the variability in each group is shown in Table 3.

The samples from each group were mixed in pens where they remained overnight. They were loaded the next morning — 20 in a crate — and transported to the Hamilton Farm Bureau, Hamilton, Mich. There, live weights were taken as they were hung on the dress-

TABLE 2—Feed conversion and mortality—9 weeks

Pen No.	Mortality	Lb. chicken per 100 lb. feed	Feed per lb. of chicken	Number	
				Males	Females
	(Percent)	(lb.)	(lb.)		
1	3.92	42.68	2.34	62	36
2	2.88	41.32	2.42	35	66
3	4.85	40.01	2.50	43	55
4	....	41.22	2.43	49	50
5	1.92	43.33	2.31	39	63
6	1.92	41.98	2.38	54	48
7	....	42.35	2.36	49	55
8	11.43	39.97	2.50	44	50
Ave....	3.27	41.63	2.40	....	....

ing line. The eviscerated weights were recorded and the birds scored for quality (Tables 4 and 5). The market grade was based on the sample using 1 to 5 point scale.

Feed

The chicks were fed a commercial broiler-starter until they were 7 weeks old. A broiler-finisher was used for the balance of the test[2].

[2]The feed for this test was manufactured by the Harris Milling Company of Mount Pleasant, Mich.

TABLE 3—Live weight and variability of each sex—9 weeks—entire group

Pen number	Males		Females	
	Ave. Wt.	Variability(*a*)	Ave. Wt.	Variability(*a*)
1.....	3.83	8.6	3.09	8.4
2.....	3.26	8.9	2.63	11.1
3.....	3.40	9.2	2.79	10.5
4.....	3.37	8.2	2.71	11.1
5.....	3.39	7.5	2.71	7.8
6.....	3.76	9.0	2.97	9.7
7.....	3.49	9.0	2.84	8.0
8.....	3.42	8.5	2.50	13.6
Average.....	3.52	....	2.76	....

(*a*) Expressed as coefficient of variation. A low numerical value of the coefficient shows greater uniformity.

TABLE 4—Live and eviscerated weights of samples and carcass yields —9 weeks

Pen number	Average weights				Carcass yields Percent of live weight	
	Live		Drawn			
	Male	Female	Male	Female	Male	Female
	(lb.)	(lb.)	(lb.)	(lb.)		
1.....	3.9	3.01	2.83	2.21	72.56	73.41
2.....	3.22	2.68	2.33	1.9	72.41	70.84
3.....	3.23	2.71	2.31	2.03	71.51	74.90
4.....	3.31	2.79	2.42	2.03	73.15	72.75
5.....	3.26	2.6	2.4	1.91	73.61	73.46
6.....	3.69	2.95	2.73	2.17	73.98	73.55
7.....	3.42	2.72	2.62	2.02	76.62	74.26
8.....	3.23	2.56	2.39	1.93	73.99	75.39
Average.....	3.41	2.75	2.50	2.03	73.46	73.52

The guaranteed analysis of the starter was crude protein, minimum 24 percent; crude fat, minimum 5.5 percent; and crude fiber, maximum 2.75 percent. The finisher was guaranteed to contain 21 per cent protein; 5.5 percent fat; and not over 2.75 percent fiber.

TABLE 5—Dressed score of samples—9 weeks(a)

Pen No.	Carcass Grades(b)										Percent Grade A
	Fleshing		Feathering		Fat		Conformation		Defects(c)		
	M	F	M	F	M	F	M	F	M	F	
1.....	1.55	1.77	1.0	1.0	1.15	1.32	1.3	1.27	1.4	1.0	80
2.....	1.89	2.09	1.11	1.14	1.55	1.5	1.33	1.23	1.16	1.0	65
3.....	1.7	2.0	1.05	1.2	1.5	1.45	1.35	1.25	1.15	1.1	65
4.....	1.61	1.85	1.05	1.0	1.61	1.4	1.28	1.1	1.22	1.0	80
5.....	1.8	2.2	1.1	1.05	1.4	1.5	1.2	1.4	1.05	1.0	60
6.....	1.4	1.85	1.1	1.05	1.3	1.3	1.2	1.15	1.1	1.0	75
7.....	1.44	2.0	1.0	1.05	1.28	1.5	1.33	1.4	1.05	1.0	60
8.....	1.85	2.3	1.05	1.05	1.4	1.5	1.45	1.4	1.05	1.25	50
Ave...	1.66	2.01	1.06	1.07	1.4	1.43	1.31	1.28	1.15	1.04	....

(a) The authors wish to express appreciation to Dr. L. E. Dawson, Poultry Dept., M. S. U. and Dr. E. S. Weisner, Michigan Department of Agriculture, for scoring and grading the dressed birds.
(b) Dressed score: 1, 2, 3, 4, 5. Based on Federal Standards of Quality; average score shown.
(c) Defects: Includes breast blisters, crooked and dented breast bones, crooked backs, etc.

Limitations

Results from such samples should not be interpreted competitively by entrants.

Relatively little reliance should be placed on information from only one test. Repeated testing will be required to reliably evaluate real performance of strains and strain crosses. It is hoped this attitude will be expressed by the entrants in using these data for other than their own information. A winner cannot be picked because of the problem of fairly evaluating the various characteristics which were observed.

CORN KERNELS IN FECES OF DAIRY CATTLE FED CORN SILAGE

By C. F. HUFFMAN and C. W. DUNCAN
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MANY DAIRYMEN are of the opinion that there is large loss of nutrients through whole corn kernels in the feces of dairy cattle when corn silage is fed. The results of early studies (Becker and Gallup 1927, 1928 and 1929), however, indicate that the loss of nutrients was small, but all of this work was done before the advent of hybrid corn. The present study was carried out to determine the number of whole corn kernels that were present in the feces of dairy cattle when silage made from hybrid corn was fed.

EXPERIMENTAL PROCEDURE

Two different hybrid corns (1954 and 1956: Michigan 480; 1955: Funk 85A) were grown in three different years and harvested in the early dent stage of maturity. The maturity of the corn is indicated by the low dry matter content (1954: 28 percent, 1956: 26.8 percent). The yields of corn harvested for silage and corn grain per acre were estimated from randomized samples taken from the field just prior to harvesting. The yields obtained for 1954, 1955, and 1956 were 15.0, 12.4 and 17.9 tons per acre of silage, respectively. On 14 percent moisture basis, the yields were 72, 59 and 66 bushels per acre, respectively. The crops were stored in tower silos.

The coefficients of digestibility were determined for each silage by using 4 dairy cows fed an all-silage ration. The cows were fed silage for a 21-day period, but the feces were collected only during the last seven days. The amount of corn kernels in each silage was estimated by hand-picking the kernels from three, 1-pound samples. The mean of the three samples was used to estimate the total amount of kernels in each feeding of silage. The kernels were separated from

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aliquot composite samples of feces by the use of a screen and water. Moisture determinations were made on the kernels obtained from both the silage and feces, but chemical analyses were made only on the silage and feces from the four cows fed the 1954 corn silage.

RESULTS AND DISCUSSION

The body weight of the cows, amount of corn silage fed, weight of the whole kernels in the silage and feces, percentage of the kernels in the feces, and the TDN content of the corn silages are shown in Table 1. The weight of the cows ranged from 725 to 1240 pounds. Corn silage consumption varied from 38 to 60 pounds per day. The smaller cows were about 2 years of age while the larger cows were mature.

The dry weight of the whole corn kernels fed in the silages ranged from 503.1 to 814.4 grams per day, while that of the kernels excreted in the feces varied from 2.0 to 64.8 grams. The percentage of whole kernels in the feces varied from 0.2 to 8.3.

Kick *et al.* (1938) fed corn kernels stained red, white, and blue to 2-to-3½-year old steers and found that the outstanding factors which

TABLE 1—Corn kernels lost in the feces of dairy cows fed corn silage

Crop year	Cow	Body wt.	Daily silage intake		Dry kernels in			TDN
					Silage	Feces	Feces	
	no.	lb.	lb.(*a*)	lb.(*b*)	g.(*c*)	g.(*c*)	percent	percent
1954	T 4	1087	60	10.7	783.3	64.8	8.3	65.2
	T 17	1032	60	11.1	788.3	39.9	5.1	68.1
	A 106	738	40	7.8	525.5	2.0	0.4	72.2
	A 107	725	38	7.4	503.1	4.0	0.8	70.6
1955	A 103	858	40	11.2	779.9	59.0	7.6	65.7
	T 66	836	40	11.2	814.4	2.0	0.2	67.2
	T 67	840	40	11.2	814.4	16.0	2.0	68.5
	T 68	804	40	11.2	814.4	9.0	1.1	68.5
1956	A 95	1240	60	16.1	630.0	9.0	1.4	61.9
	K 249	1126	49	13.0	510.3	5.0	1.0	69.6
	A 71	1118	60	16.1	630.0	5.0	0.8	68.9
	585	1150	60	16.1	630.0	4.0	0.6	63.1
Average ..	.....	963	49	11.9	685.3	18.3	2.7	67.5

(*a*) Wet basis.
(*b*) Dry basis.
(*c*) Average per day.

affected the length of time that the corn kernels were retained in the digestive tract depended on the physical condition of the animal and the physical characteristics of the ingesta. When the animal had a rough hair coat and a generally listless appearance, the ingesta were relatively dry and the corn and hay were mixed in a rather firm mass. Under these conditions, rumination occurred normally and the corn and hay were regurgitated and masticated together and no corn kernels appeared in the feces.

When the moisture content of the rumen ingesta was high, fewer corn kernels were regurgitated and a larger number appeared in the feces. These findings may explain why the number of whole corn kernels in the feces is so low when corn silage is fed compared with that of dry whole corn. The kernels are high in moisture and thoroughly mixed with the silage, which probably facilitates regurgitation and subsequent chewing of the kernels. LaMaster and Morrow (1927) reported a loss of 1.9 percent of the whole kernels in the feces when corn silage was fed with hay and ground grain. Two cows were used in their study.

Becker and Gallup (1929) reported that 4.4 percent of the weight of the whole kernels in silage was recovered from the feces. These investigators used four cows and fed a ration consisting of 30 pounds of silage made from Reid Yellow Dent corn, 10 pounds of alfalfa hay, and ground grain. The corn was harvested in the glazed stage. The higher loss of kernels in the feces, observed by Becker and Gallup, may have been due to the greater maturity of the corn at the time of harvest; this is indicated by the high content of dry matter (30.7 percent).

From the above reports, it is apparent that the loss of nutrients in corn silage, as a result of the passage of whole kernels into the feces, is small compared to the loss of whole kernels in feces when either sorghum silage or whole dry corn are fed. LaMaster and Morrow (1929) reported that 27.5 percent of the whole grain in cane silage was excreted in the feces of dairy cows. Becker and Gallup (1927 and 1928) also observed losses which represented 33.9 and 49.5 percent of the grain in cane and kafir silages, respectively, in the feces of dairy cows. Fitch and Wolberg (1934) recovered 42.9 percent of the Kansas Orange and 36.2 percent of the Atlas sorghum seed in the feces of cows. The investigations of Shaw and Norton (1906) showed the following losses of whole grains in feces: whole corn fed to mature dairy cows, 22.7 percent; yearling heifers, 10.8 percent; and only 6.3 percent with

calves. Wilbur (1933) used whole corn as part of a grain mixture fed to dairy cows and reported that 30 to 35 percent of the whole corn and only 5 to 10 percent of the cracked corn passed into the feces. According to Wallis and Olson (1941), 19.9 percent of the whole corn fed to dairy cows was recovered in the feces. These investigators also found no significant difference in the nutritive value of medium or finely ground corn.

The chemical composition of the silage, whole corn kernels in the silage, and the corn kernels recovered in the feces of the cows fed the 1954 crop is shown in Table 2. The crude protein, crude fiber and nitrogen-free extract (NFE) content of the dry matter of the kernels from corn silage and the kernels from the feces were remarkably close. The crude fat (ether extract) was 5.6 percent in the kernels from the silage and 3.9 percent in those recovered from the feces. These results are in agreement with those of Olson (1942) who reported that very little of the nutritive value had been removed from kernels that appeared in the feces. Similar results were reported by LaMaster and Morrow (1929) and Darnell and Copeland (1935). Becker and Gallup (1928) stated that chemical analyses only showed slight losses of protein, ether extract, and ash after the corn grain in silage had passed through the cow's digestive tract.

Some corn bran was observed in the feces of the cows used in this experiment, but the starch had been completely digested. Becker and Gallup made a similar observation. The presence of bran from the cracked kernels in the feces gave the appearance of more whole kernels than were actually present.

TABLE 2—Percentage composition of the 1954 corn silage, corn kernels in the silage, and in the feces

(All values expressed on the dry basis)

	Dry matter	Ash	Crude protein	Ether extract	Crude fiber	NFE
Silage	28.0	4.5	7.6	1.3	21.8	64.8
Kernels in silage	54.3	1.1	7.3	5.6	3.4	82.6
Kernels in feces						
Cow T 4	43.5	1.0	7.5	3.9	3.9	83.7
T 17	41.4	1.1	7.5	3.8	3.7	83.9
A 106	44.8	1.0	7.5	3.9	3.9	83.7
A 107	44.8	1.0	7.5	3.9	3.9	83.7
Average	43.6	1.0	7.5	3.9	3.9	83.7

The TDN values obtained for the silages fed to the individual cows are also presented in Table 1, but no relationship was found between the number of kernels present in the feces and the TDN value of the silage.

SUMMARY

Three different hybrid corn silages were fed to 12 dairy cows to determine the number of whole kernels that appeared in the feces. The silages were harvested in the early-dent stage.

Only a relatively small number of the whole kernels originally present in the silage were recovered in the feces (range 0.2 to 8.3 percent, average 2.7).

Chemical analyses of the whole kernels in the silage and of those recovered in the feces revealed no significant change in the chemical composition of the corn grain as a result of passing through the digestive tract of the dairy cow.

LITERATURE CITED

Becker, R. B., and W. D. Gallup (1927). Utilization of the grain in kafir and cane silage by dairy cows. Jour. Agr. Research 35: 279-282.

———— (1928). Utilization of grain in silage. Amer. Soc. Animal Production Proc. 1927: 38-32.

———— (1929). Grain losses in feeding corn silage to dairy cows. Jour. Agr. Research 39: 23-227.

Darnell, A. L., and O. C. Copeland (1935). Ground versus unground grain for lactating dairy cows. Texas Agr. Expt. Sta. Bul. 530.

Fitch, J. B., and F. B. Wolberg (1934). Utilization of sorgo seeds by dairy cows. Jour. Dairy Sci. 17: 343.

Kick, C. H.; P. Gerlaugh, and A. F. Schalk (1938). Some factors affecting length of time whole corn kernels are retained in the rumen of steers. Amer. Soc. Animal Production Proc. 1937: 95-97.

LaMaster, J. P., and K. S. Morrow (1929). Corn silage versus sweet sorghum silage for milk production. S. C. Agr. Expt. Sta. Bul. 254.

Olson, T. M. (1942). The effect of fineness of grinding grain on milk production. S. D. Agr. Expt. Sta. Bul. 358.

Shaw, R. S., and H. W. Norton, Jr. (1906). Feeding whole corn grain. Mich. Agr. Expt. Sta. Bul. 242.

Wallis, G. C., and T. M. Olson (1941). How fine should grain be ground for milk cows? S. D. Agr. Expt. Sta. Cir. 34.

Wilbur, J. W. (1933). Grinding grain for dairy cows. Purdue Univ. Agr. Expt. Sta. Bul. 372.

THE EFFECTS OF AGE ON THE SOCIAL ORGANIZATION OF CHICKENS

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RESEARCH ON THE SOCIAL BEHAVIOR of domestic fowl, especiall chickens, has recently been reviewed by Guhl (1953) and Wood Gush (1955). These reviews indicate the complexity of these event and suggest areas in which more data are needed. The effects of ag on social organization is one area in which data are available at th extremes but not in the middle ranges. Guhl (1953) in his review o the literature cited some unpublished material on the age at whic peck orders develop. These data are now available in published for (1958). However, the large bulk of work has been done with matur birds often more than 12 months old.

Preliminary observations of groups of White Leghorns have sug gested that social interactions differ in frequency and vigor as function age. The present study was designed to investigate the short run characteristics of the development of social orders among femal chickens of differing ages.

METHOD

Thirty White Leghorn females were obtained from Michiga State University flocks in July, 1957. The ages at the beginning of th study and numbers of each age were as follows: 17 months, 1 birds; 5 months, 12 birds; 3½ months, six birds. The smaller number o 3½-month-old birds was due to a shortage of this age group when th study began.

After birds were selected from large flocks, they were placed i isolation in laying batteries for 10 to 12 days. Food and water wer given *ad lib.* Isolation was used to break up any existing social organ zation among birds from the same flocks. On the last day of isolatio

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prior to assembling birds into pens according to their ages, each bird was weighed, banded, and marked on the back with a spot of color to facilitate identification.

The ages of the birds and numbers placed in each floor pen were as follows: 17 months, 2 pens with 6 birds per pen; 5 months, 2 pens with five birds in one pen and four in the other (one had died in isolation and two died during the course of the observations); 3½ months, one pen with six birds. The floor pens were 8 x 10 feet and food and water were given *ad lib.*

The particular birds assigned to a pen were released simultaneously into the pen and social interactions were observed for 30 minutes. Four more observations were made for a period of 20 minutes at each pen. These observations took place within the week after the birds were assembled. The order of observing the pens was randomized on each day and a total of three morning and two afternoon observations were made.

Instances of pecks, fights, and threats were recorded as indexes of social organization among the birds in each pen. A peck was de-

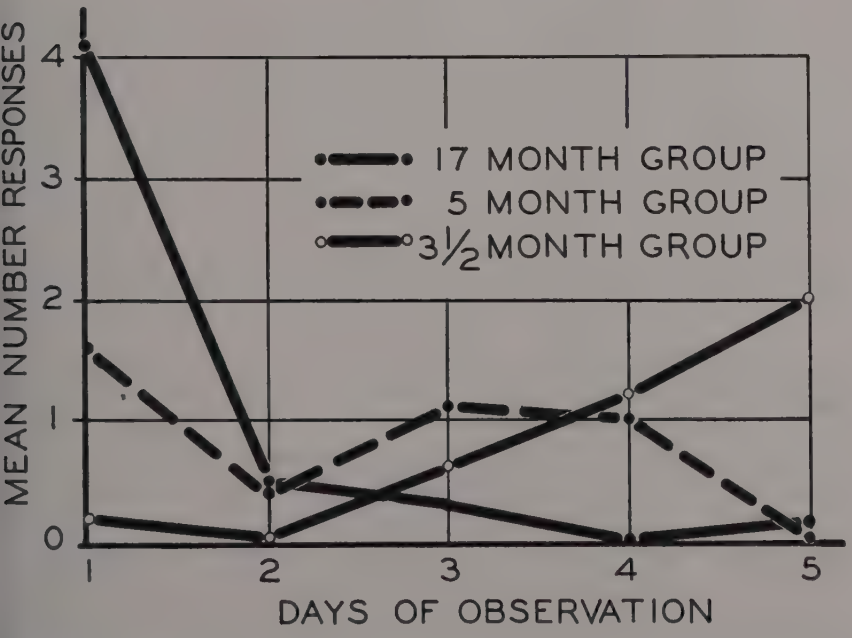

Fig. 1. Means of numbers of pecks, fights and threats for each group.

fined as a peck on the head or neck of another bird. Pecking at the body, feather picking, is presumably independent of social status. Delivering the peck was taken as evidence of social dominance, and receiving a peck was taken as evidence of social submission.

A fight was defined as two birds flying together and pecking at about the same time. Moving forward in a fight was taken as evidence of social dominance, and withdrawing was taken as evidence of social submission. A threat was defined as movement of one bird toward another which led the approached bird to withdraw. Typically, the threat was an abortive peck.

On the eighth day, after the social orders had been estimated in each pen, tests were conducted to evaluate the reactions of dominant birds of each age to: (1) a mature, White Leghorn male and (2) a suddenly presented, unfamiliar stimulus. A male was introduced for three minutes into each pen and his reactions and the reactions of the females were noted.

After the males had been removed a white cloth was suddenly inserted on a stick through the wire and dangled in each pen. This was repeated several times. Reactions of the birds, especially the dominant birds, were noted.

RESULTS AND DISCUSSION

Means of numbers of pecks, fights, and threats made by each age group on each day of observation are shown in Fig. 1. The curve for the 17-month group shows strong evidence of dominant and submissive behaviors when the birds were first assembled and then little or no additional evidence of the existence of the social order. Conversely, the 3½-month birds showed almost no dominant and submissive behaviors for the first several days.

The 5-month group was moderately active during each observation period but the last. Statistical analysis from Siegel (1956) of the difference between the age groups in total occurrences of pecks, fights and threats on day one, the day the groups were assembled, yielded a significant value of the Kruskal-Wallis H statistic ($H = 8.411$, $P < .01$). Thus, it is concluded that the differences between the groups in occurrences of social interactions are larger than could be expected by chance.

The fact that the various age groups showed different amounts of social activity at different times after having been assembled means

of course, that the individuals within each group behave differently. Specifically, the 17-month-old birds, immediately after having been assembled, pecked, fought, and threatened one another, while the younger birds did this to a lesser extent. Relative to the vigor of the organization process, the 17-month birds had a total of 19 fights, all during the first two observation periods, whereas all of the other birds together had a total of only three fights during the entire experiment.

Several hypotheses can be proposed to account for these differences in social behaviors as a function of the ages of the birds. The first is that levels of maturation differ between ages 3½-months, 5-months and 17-months and these differences in maturation account for the behavior differences.

While no known relationship exists between this factor and degree of social activity at these ages, Guhl (1958) has shown that pecking increased from hatching to about 10 weeks after which age the data is not available. This relationship may extend to mature birds and may be independent of learning. The second hypothesis is that the amounts of past social experience in social groups accounts for the obtained differences between the age groups.

Specifically, it is postulated that the more the social experience, particularly the experience of changing social groups, the faster and more vigorous the organization process. That is, the birds are presumed to learn to organize. Histories of the individuals in the 17-month group indicated that each of them had been in several different flocks during its life, while histories of the younger birds indicated more limited experience of being changed from one social group to another. The relative contributions of these two factors, maturation and learning, can be assessed in subsequent experimentation.

The organization of the social groups within each pen were essentially linear with the exception of pen two of the 17-month birds. That is, in these linear organizations the top bird, alpha bird, pecked all others, the beta bird pecked all under her, etc. Instances of inversion of the social order were noted in two pens, pen one of 17-month birds and pen one of 5-month birds. In these cases, low-ranking birds pecked the alpha birds on several occasions. Bird-6 in pen one of the 17-month birds neither pecked nor was pecked by any other bird in the pen during the observation periods. She was put in the bottom position in the social order but actually does not be-

long in it at all. Other such cases in which a bird neither pecks nor is pecked have been noticed in other work and suggest themselves for additional study.

The alpha birds in both pens of 17-month-old birds and the alpha bird in one pen of the 5-month group attacked the male when it was put into their pen. There was no contact between the alpha birds in the two other pens and the males put into those pens. Bird-6 in pen one of the 17-month group attacked the male when he was put into their pen as did bird-5 in pen two of the 5-month group. Bird-6 was the one which had had no interactions with her pen mates, and bird-5 had previously pecked the alpha bird in her pen.

Thus, in summary the males were attacked by three birds in the 17-month group, two birds in the 5-month group and no birds in the 3½-month group. This also suggests that the frequency of social interactions increases with age. The finding of aggressive reactions of the alpha birds toward the males is consistent with the finding by Guhl (1950) that dominant birds are less receptive than lower-ranking birds in small groups.

The question of the generality of the aggressive reactions of alpha birds was also investigated in the tests in which a sudden, novel visual stimulus was presented in each pen. Waving the white cloth in each pen did *not* lead to any noticeably differential reactions among birds in a pen.

In particular the alpha birds did not make any aggressive or forward moves to this stimulus, although the 17-month alpha birds had made such responses to the male when it was introduced into the pens. A variety of test situations will have to be investigated, however, before the conclusion can be reached that the dominant bird is aggressive only to other birds.

It is of interest to note that the weights of the birds at the end of the study and their status in the social order bore an inverse relationship to each other. That is, the mean of the weights of the two top-ranking birds was less than the mean of the weights of the two bottom-ranking birds in each of the four pens containing mature birds.

The only inversion occurred in the 3½-month group in which the mean of the weight of the two top-ranking birds was 0.2 pounds more than that of the two bottom-ranking birds. While these data are not meant to argue for increased status with decreased weight, they do corroborate Collias's finding (1943) that weight is of small importance as a determinant of the outcome of social interactions.

SUMMARY

White Leghorn females of differing ages were selected to investigate the short-run development of social order as a function of their ages. After isolation, birds were assembled into pens according to their ages: 3½-month group, 5-month group, and 17-month group. Dominance and submissive behaviors were measured.

When first assembled the oldest birds show the most dominant and submissive behaviors; on subsequent days the age-social activity relationship was reversed. The effects of the age variable are interpreted in terms of past learning and biological factors. Tests of the generality of the aggressive reactions of the alpha birds showed that the aggressive reactions extended to mature males introduced into the pens for the mature females but did not extend to a novel, visual stimulus suddenly introduced into the pens.

ACKNOWLEDGMENTS

The writer wishes to thank the Department of Poultry Husbandry for providing the birds and space and Dr. R. K. Ringer of that department and Dr. M. R. Denny of the Department of Psychology, for critical reading of the manuscript.

LITERATURE CITED

Collias, N. E. (1943). Statistical analysis of factors which make for success in initial encounters between hens. Amer. Nat., 77, 519-538.

Guhl, A. M. (1950). Social dominance and receptivity in the domestic fowl. Physiol. Zool., 23, 261-366.

(1953). Social behavior of the domestic fowl. Kansas Agr. Expt. Sta. Tech. Bul. 73.

(1958). The development of social organization in the domestic chick. Anim. Behav., 6, 92-111.

Siegel, S. (1956). *Non-parametric statistics.* New York: McGraw-Hill.

Wood-Gush, D. G. M. (1955). The behavior of the domestic chicken: A review of the literature. Brit. Jour. Anim. Behav., 3, 81-110.

MICHIGAN SOIL TEST SUMMARY[1]

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Soil testing is by no means a new tool in diagnosing soil and plant deficiencies. Great advances, however, have been made in the past decade, in both the number of samples tested and the accuracy by which these soil tests are carried out. The correlation of soil test results with crop yields has provided additional information whereby it will be possible to more accurately evaluate and interpret soil test results.

Prior to 1946 the soil testing laboratory, in cooperation with the soil extension specialists at Michigan State University, analyzed soil and made fertilizer recommendations over the entire state. The demand for this service was apparent from the increase in the number of samples submitted. In order to facilitate and expedite the work, the program was decentralized and placed on a county basis.

The first county laboratory was established in Branch county in 1946. Such laboratories proved very successful and the demand for the service was reflected in their rapid spread throughout the state. There are presently 57 county laboratories serving both rural and urban dwellers. The locations of these laboratories are shown in Fig. 1. The number of samples tested since 1948 is shown in Table 1.

The county laboratories are under the direct supervision of the county extension directors and are financed by the counties. The laboratory equipment and techniques are supervised by staff members from the Soil Science department of Michigan State University.

The soil samples at present are analyzed chemically for pH (soil reaction), phosphorus and potassium. In addition, some laboratories test for calcium and magnesium. Fertilizer recommendations are made by the county extension directors from the test results and

[1]The authors are grateful to the County Extension Directors, of the State of Michigan for their assistance in obtaining the data presented in this report.

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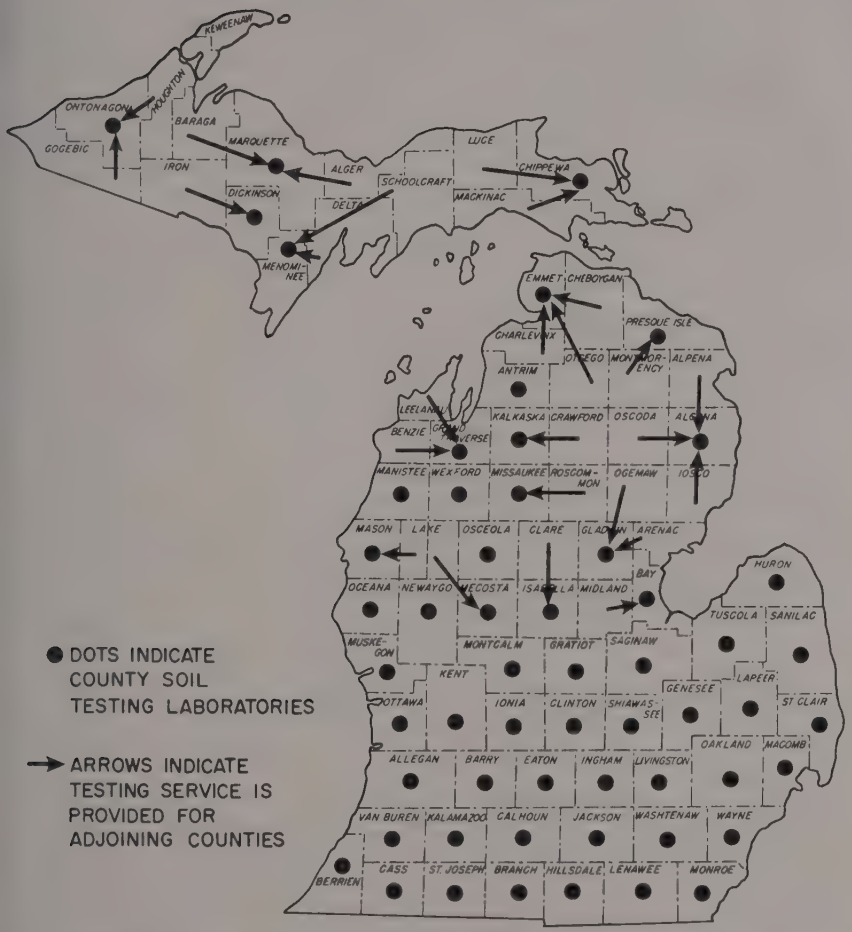

Fig. 1. Michigan counties served by soil testing laboratories.

TABLE 1—Number of samples tested by the county soil testing laboratories and the central laboratory at Michigan State University for the period 1948 to 1957

Year	Number of samples tested	Year	Number of samples tested
1948	14,500	1953	42,925
1949	25,068	1954	63,078
1950	28,477	1955	56,116
1951	34,313	1956	56,758
1952	43,553	1957	64,993

other data supplied on the soil information sheet. These include soil texture, drainage, topography, erosion, crop rotation and the time and rate of previous soil treatments.

TABLE 2—Number of samples tested by county soil testing laboratories during 1957

	County	Number of soil samples tested		County	Number of soil samples tested
01	Alcona	431	43	Lake	*
02	Alger	*	44	Lapeer	916
03	Allegan	1,208	45	Leelanau	*
04	Alpena	*	46	Lenawee	744
05	Antrim	294	47	Livingston	1,046
06	Arenac	*	48	Luce	*
07	Baraga	*	49	Mackinac	*
08	Barry	1,263	50	Macomb	506
09	Bay	491	51	Manistee	*
10	Benzie	*	52	Marquette	300
11	Berrien	6,286	53	Mason	1,479
12	Branch	1,373	54	Mecosta	941
13	Calhoun	1,659	55	Menominee	134
14	Cass	2,144	56	Midland	*
15	Charlevoix	*	57	Missaukee	742
16	Cheboygan	*	58	Monroe	479
17	Chippewa	108	59	Montcalm	1,572
18	Clare	*	60	Montmorency	*
19	Clinton	1,288	61	Muskegon	1,111
20	Crawford	*	62	Newaygo	1,538
21	Delta	*	63	Oakland	865
22	Dickinson	357	64	Oceana	767
23	Eaton	1,282	65	Ogemaw	*
24	Emmet	850	66	Ontonagon	403
25	Genesee	669	67	Osceola	1,010
26	Gladwin	258	68	Oscoda	*
27	Gogebic	*	69	Otsego	*
28	Grand Traverse	1,275	70	Ottawa	3,249
29	Gratiot	1,546	71	Presque Isle	296
30	Hillsdale	2,400	72	Roscommon	*
31	Houghton	*	73	Saginaw	528
32	Huron	925	74	St. Clair	1,220
33	Ingham	853	75	St. Joseph	1,322
34	Ionia	985	76	Sanilac	756
35	Iosco	*	77	Schoolcraft	*
36	Iron	*	78	Shiawassee	628
37	Isabella	918	79	Tuscola	433
38	Jackson	1,464	80	Van Buren	2,652
39	Kalamazoo	1,784	81	Washtenaw	930
40	Kalkaska	655	82	Wayne	834
41	Kent	1,500	83	Wexford	538
42	Keweenaw	*			

*No data.

A decentralized soil testing system is particularly advantageous because county extension directors are familiar with the farms and agronomic problems on a local level. In many instances they are able to make personal farm visits and discuss the soil test results with the farmer and suggest corrective soil management practices.

It has been stated[2] that the main purpose of soil testing is to let the individual farmer know the fertilizer and lime needs of his fields. However, some farmers do not have their soils tested; and others have only parts of their farms tested. Better use of lime and fertilizer may be obtained on the untested fields by drawing on test information from the nearby fields. This is possible by use of soil test summaries.

This summary has been compiled from data obtained in the county laboratories for 1957.

A Survey of the Soil Acidity Status of Michigan Soils

A definite pattern in relation to soil acidity and geographical location appears to exist in Michigan (Fig. 2). A high percentage of western Michigan soils are acid with the percentage decreasing gradually toward the central portion. A considerably lower percentage of the "thumb" area soils fall in the acid grouping.

Thirty-two of the counties for which these data are available were classified as having over 75 percent of their soils testing below pH 6.8; 28 counties as having 60 to 75 percent below pH 6.8; seven counties with 50 to 60 percent below pH 6.8; and two counties each were classified as having 25 to 50 percent and less than 25 percent of their soils testing below 6.8 pH.

These data emphasize the need for lime and readily show those areas where the probability of such a need is great. It must be understood, however, that the data represent relatively large areas and many localized areas within a county may not need lime.

A more detailed breakdown of the pH ranges is shown in Table 3. These data are based on the 1957 data as contrasted to 15 years data presented in Fig. 2. Good agreement exists between the two sets of data.

A Survey of the Phosphorus Status of Michigan Soils

The graphic representation of Fig. 3 and tabulated data in Table 4, show the percent of soil samples testing medium or low in phosphorus.

[2]Potash News Letter for the Midwest. American Potash Institute, Incorporated, Lafayette, Indiana. No. 90. September-October 1957.

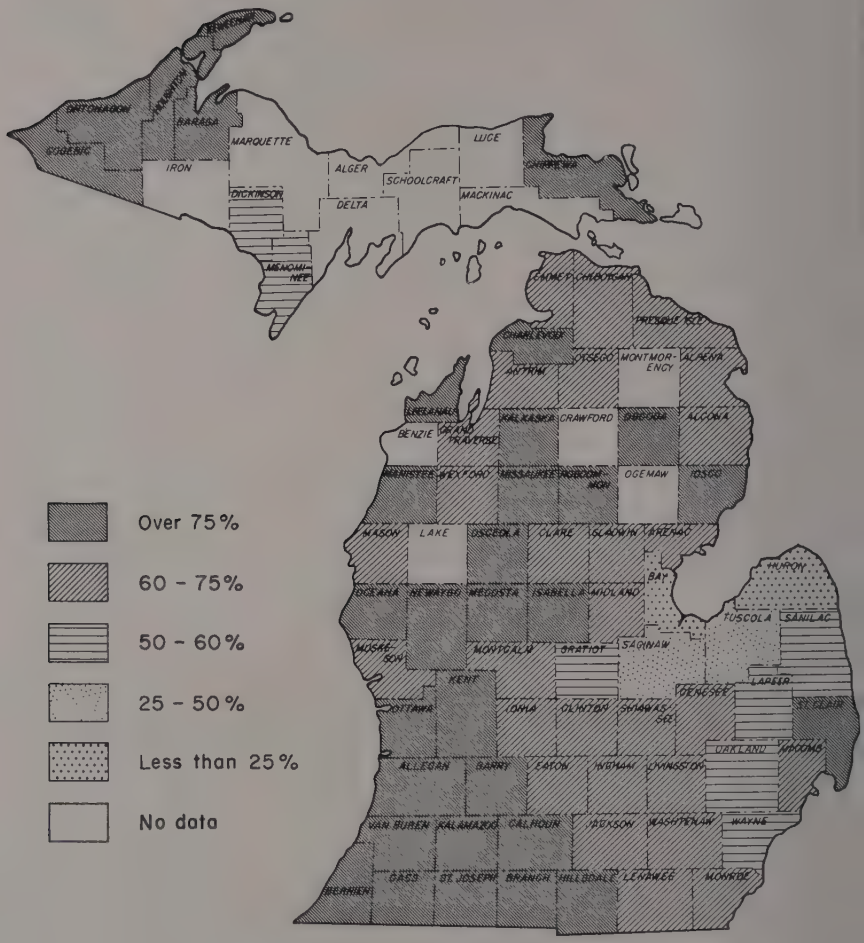

Fig. 2. Percent of all soil samples testing below pH 6.8.

Soil samples testing below 25 pounds of phosphorus per acre at a depth of 6 inches are considered low; soil samples testing between 25 and 50 pounds and over 50 pounds per acre 6 inches deep are considered medium and high, respectively. If the soil pH is 7.0 or above, 100 pounds of phosphorus per acre 6 inches deep are required to be considered as high. This is due to the "fixation" or unavailability of phosphorus at the higher pH levels.

These phosphorus levels are based on a 0.13 N HCl soil extractant having an extract to soil ratio of 4:1.

TABLE 3—A survey of the soil acidity status of Michigan soil

	County	pH—Percentage					
		Below	Between				Above
		5.1	5.2-5.7	5.8-6.3	6.4-6.9	7.0-7.5	7.5
01	Alcona	3.0	22.0	37.0	20.0	15.0	3.0
02	Alger	*					
03	Allegan	2.0	21.0	37.0	29.0	10.0	1.0
04	Alpena	1.0	11.0	28.0	34.0	23.0	3.0
05	Antrim	7.0	34.0	31.2	20.0	6.8	1.0
06	Arenac	2.0	12.0	19.0	31.0	24.0	12.0
07	Baraga	*					
08	Barry	*					
09	Bay	0.4	0.9	5.4	19.9	43.2	32.2
10	Benzie	*					
11	Berrien	19.6	25.8	30.8	18.8	4.2	0.8
12	Branch	1.0	14.0	42.0	33.0	9.0	1.0
13	Calhoun	2.5	21.4	42.3	25.5	7.2	1.1
14	Cass	6.0	20.0	32.0	32.0	9.0	1.0
15	Charlevoix	1.0	4.0	24.0	39.0	23.0	9.0
16	Cheboygan	0.0	3.0	35.0	29.0	18.0	15.0
17	Chippewa	*					
18	Clare	0.0	10.0	43.0	37.0	10.0	0.0
19	Clinton	4.0	21.0	39.0	25.0	10.0	1.0
20	Crawford	*					
21	Delta	*					
22	Dickinson	0.9	4.0	20.9	39.1	25.5	9.6
23	Eaton	0.0	2.0	29.0	42.0	27.0	0.0
24	Emmet	0.0	5.0	27.0	35.0	24.0	9.0
25	Genesee	0.0	11.0	33.0	36.0	17.0	3.0
26	Gladwin	0.0	6.0	33.0	33.0	21.0	7.0
27	Gogebic	1.7	23.0	50.0	17.2	6.4	1.7
28	Grand Traverse	0.9	16.1	48.1	26.9	5.6	2.4
29	Gratiot	1.0	1.0	8.0	40.0	40.0	10.0
30	Hillsdale	0.0	10.0	60.0	25.0	5.0	0.0
31	Houghton	7.0	56.7	26.4	6.0	3.4	0.5
32	Huron	0.0	0.0	2.0	17.0	40.0	41.0
33	Ingham	3.1	16.2	36.0	32.9	10.7	1.1
34	Ionia	0.4	9.0	44.0	38.0	8.0	0.6
35	Iosco	4.0	18.0	42.0	23.0	13.0	0.0
36	Iron	*					
37	Isabella	4.0	27.0	40.0	23.0	5.0	1.0
38	Jackson	3.0	18.0	37.0	33.0	7.0	2.0
39	Kalamazoo	0.2	20.0	46.4	22.7	8.8	1.9
40	Kalkaska	0.4	19.8	48.2	25.7	4.6	1.3
41	Kent	*					
42	Keweenaw	7.0	56.7	26.4	6.0	3.4	0.5
43	Lake	*					
44	Lapeer	7.1	21.8	32.8	24.7	10.4	3.2
45	Leelanau	*					
46	Lenawee	0.0	3.0	12.0	56.0	24.0	5.0

*No data.

TABLE 3—Concluded

County	pH—Percentage					
	Below	Between				Above
	5.1	5.2-5.7	5.8-6.3	6.4-6.9	7.0-7.5	7.5
47 Livingston	0.4	10.3	33.0	30.1	25.4	0.8
48 Luce	*					
49 Mackinac	*					
50 Macomb	2.0	8.0	31.0	38.0	20.0	1.0
51 Manistee	1.9	15.8	37.7	30.7	12.3	1.6
52 Marquette	*					
53 Mason	3.7	16.0	31.5	29.9	14.7	4.2
54 Mecosta	2.4	25.2	37.8	24.4	8.2	2.0
55 Menominee	0.5	3.1	7.1	20.3	44.2	24.8
56 Midland	*					
57 Missaukee	4.0	26.0	51.0	13.0	5.0	1.0
58 Monroe	0.2	3.9	25.5	44.6	24.3	1.5
59 Montcalm	1.3	15.9	44.0	28.5	8.0	2.3
60 Montmorency	*					
61 Muskegon	5.0	16.6	31.5	43.8	3.0	0.1
62 Newaygo	4.4	12.0	25.2	48.5	8.1	1.8
63 Oakland	5.1	12.7	26.9	36.1	15.1	4.1
64 Oceana	3.0	23.0	39.0	20.0	11.0	4.0
65 Ogemaw	*					
66 Ontonagon	0.7	36.2	45.6	13.8	2.3	1.4
67 Osceola	1.0	43.0	35.0	13.0	5.0	3.0
68 Oscoda	2.0	26.0	52.0	14.0	6.0	0
69 Otsego	6.0	4.0	21.0	35.0	32.0	2.0
70 Ottawa	1.9	23.2	38.4	30.4	5.8	0.3
71 Presque Isle	0.2	5.8	27.9	44.7	11.0	10.4
72 Roscommon	4.0	26.0	51.0	13.0	5.0	1.0
73 Saginaw	0.0	3.0	13.0	26.0	30.0	28.0
74 St. Clair	0.5	17.0	40.0	36.0	6.0	0.5
75 St. Joseph	4.2	18.8	33.4	29.4	12.0	2.2
76 Sanilac	0.8	5.8	14.9	38.0	36.0	4.5
77 Schoolcraft	*					
78 Shiawassee	2.0	12.0	30.0	34.0	16.0	6.0
79 Tuscola	0.3	6.0	16.8	28.4	40.0	8.5
80 Van Buren	24.9	26.3	27.9	15.3	5.1	0.5
81 Washtenaw	4.3	16.8	29.6	30.7	13.5	5.1
82 Wayne	2.0	7.0	15.0	30.0	35.0	11.0
83 Wexford	0.2	9.2	46.0	36.0	8.0	0.6

*No data.

As shown in Fig. 3 and Table 4, 54 of the counties for which data are available were classified as having 75 to 100 percent of their soils testing medium or low in phosphorus and 13 counties as having 50 to 75 percent of their soils with that test. There were no counties with more than 50 percent of their soils testing high.

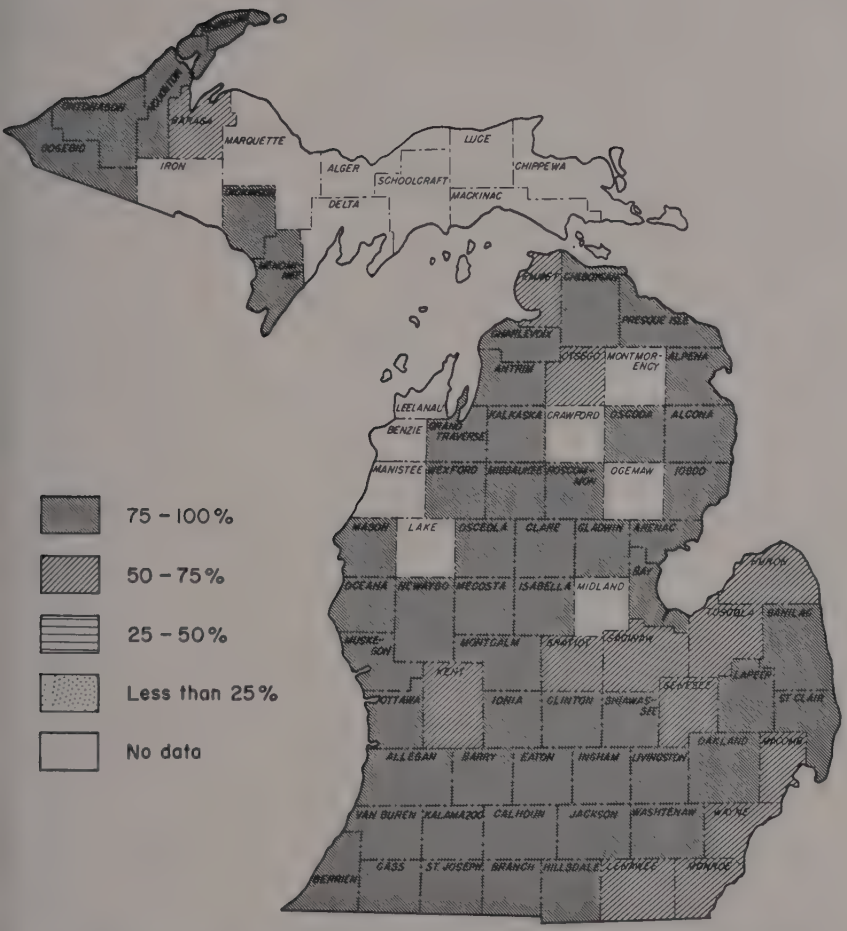

Fig. 3. Percent of soil samples testing medium or low in phosphorus.

Fig. 4 shows the percent of soil samples testing low in phosphorus. Twenty-four of the counties for which these data are available were classified as having 75 to 100 percent of their soils testing low; 34 counties had 50 to 75 percent with a low test; eight counties had 25 to 50 percent with a low test and only one had less than 25 percent of their soils testing low.

It is apparent from these data that most of the soils in the state are inherently low in phosphorus and would be expected to respond to phosphorus fertilization.

TABLE 4—The percentage of soil samples testing medium or low in phosphorus and postassium, 1957

	Percentage of soil samples testing medium or low			Percentage of soil samples testing medium or low	
	Phosphorus	Potassium		Phosphorus	Potassium
Alcona	98.0	83.0	Lake	(a)	(a)
Alger	(a)	(a)	Lapeer	87.0	69.8
Allegan	89.0	89.0	Leelanau	(a)	(a)
Alpena	95.0	80.0	Lenawee	60.0	47.0
Antrim	90.8	77.4	Livingston	96.5	94.0
Arenac	78.0	83.0	Luce	(a)	(a)
Baraga	66.6	70.0	Mackinac	(a)	(a)
Barry	80.0	60.0	Macomb	59.0	81.0
Bay	80.2	91.0	Manistee	(a)	(a)
Benzie	(a)	(a)	Marquette	(a)	(a)
Berrien	79.0	75.0	Mason	88.9	84.6
Branch	83.0	90.0	Mecosta	86.6	86.8
Calhoun	89.2	81.3	Menominee	79.6	70.0
Cass	89.0	86.0	Midland	(a)	(a)
Charlevoix	85.0	84.0	Missaukee	95.0	93.0
Cheboygan	91.0	83.0	Monroe	58.1	83.5
Chippewa	(a)		Montcalm	76.0	83.0
Clare	100.00	95.0	Montmorency	(a)	(a)
Clinton	95.0	78.0	Muskegon	87.0	66.0
Crawford	(a)	(a)	Newaygo	81.0	66.7
Delta	(a)	(a)	Oakland	83.9	65.3
Dickinson	96.6	89.0	Oceana	89.0	86.0
Eaton	97.0	74.5	Ogemaw	(a)	(a)
Emmet	72.0	80.0	Ontonagon	96.2	53.6
Genesee	68.0	60.0	Osceola	99.0	75.0
Gladwin	86.0	85.0	Oscoda	99.0	96.0
Gogebic	86.2	77.6	Otsego	71.0	60.0
Grand Traverse	94.0	85.3	Ottawa	88.9	65.4
Gratiot	65.0	70.0	Presque Isle	88.3	63.0
Hillsdale	95.0	95.0	Roscommon	95.0	93.0
Houghton	92.5	78.6	Saginaw	53.0	80.0
Huron	71.0	81.0	St. Clair	88.0	71.0
Ingham	88.0	70.0	St. Joseph	87.2	86.7
Ionia	91.0	84.0	Sanilac	94.3	96.0
Iosco	93.0	86.0	Schoolcraft	(a)	(a)
Iron	(a)	(a)	Shiawassee	81.0	85.0
Isabella	95.0	87.0	Tuscola	68.9	45.0
Jackson	90.0	90.0	Van Buren	79.1	60.0
Kalamazoo	89.3	84.1	Washtenaw	87.6	81.6
Kalkaska	97.7	96.7	Wayne	52.0	66.0
Kent	70.0	72.0	Wexford	96.6	95.0
Keweenaw	92.5	78.6			

(a) Insufficient samples on which to base estimate.

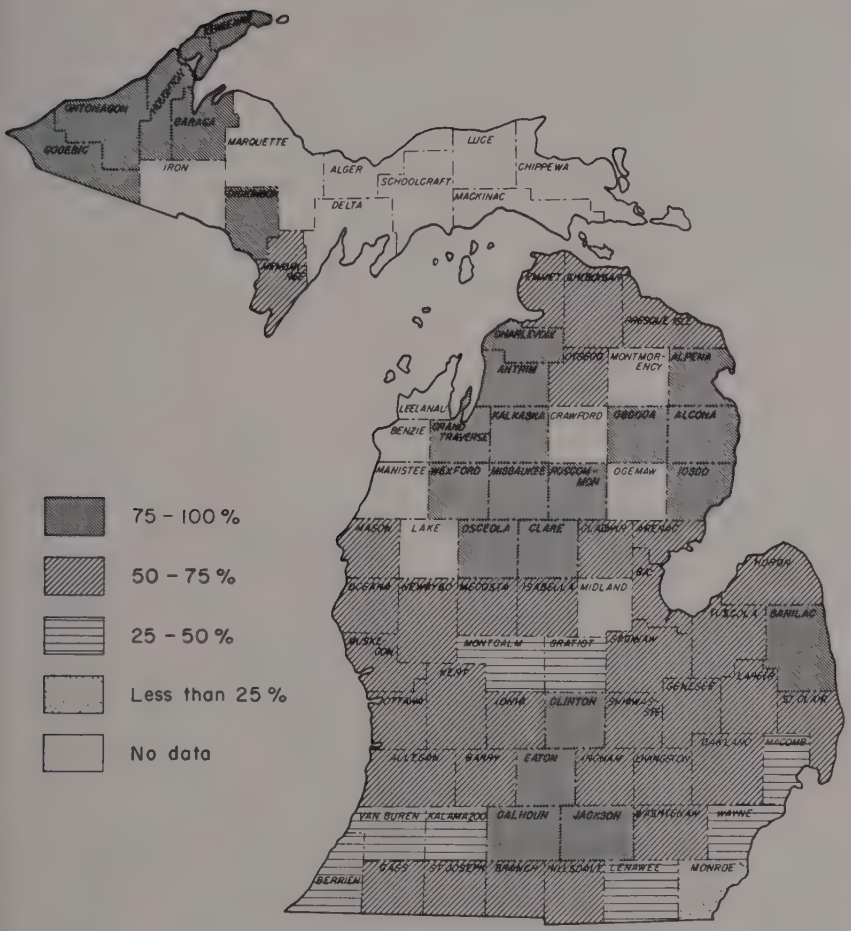

Fig. 4. Percent of soil samples testing low in phosphorus.

A Survey of the Potassium Status of Michigan Soils

Soils testing below 100 pounds of potassium per acre 6 inches deep are considered low. Soils testing between 100 and 175 pounds per acre 6 inches deep are considered medium and those testing over 175 pounds per acre 6 inches deep are considered high. These levels are also based on a 0.13 N HCl soil extractant having an extract to soil ratio of 4:1.

On this basis, 46 of the counties for which these data are available were classified as having 75 to 100 percent of their soils testing

medium or low (Fig. 5 and Table 4) and six of the counties were classified as having 75 to 100 percent of their soils testing low (Fig. 6). A similar comparison shows 19 counties having 50 to 75 percent of their soils testing medium or low and 32 counties having 50 to 75 percent of their soils testing low. Only two counties had 25 to 50 percent of their soils testing medium or low, and no counties had less than 25 percent testing medium or low (Fig. 5). As shown in Fig. 6, 27 counties had 25 to 50 percent of their soils testing low and only two counties had less than 25 percent of their soils testing low.

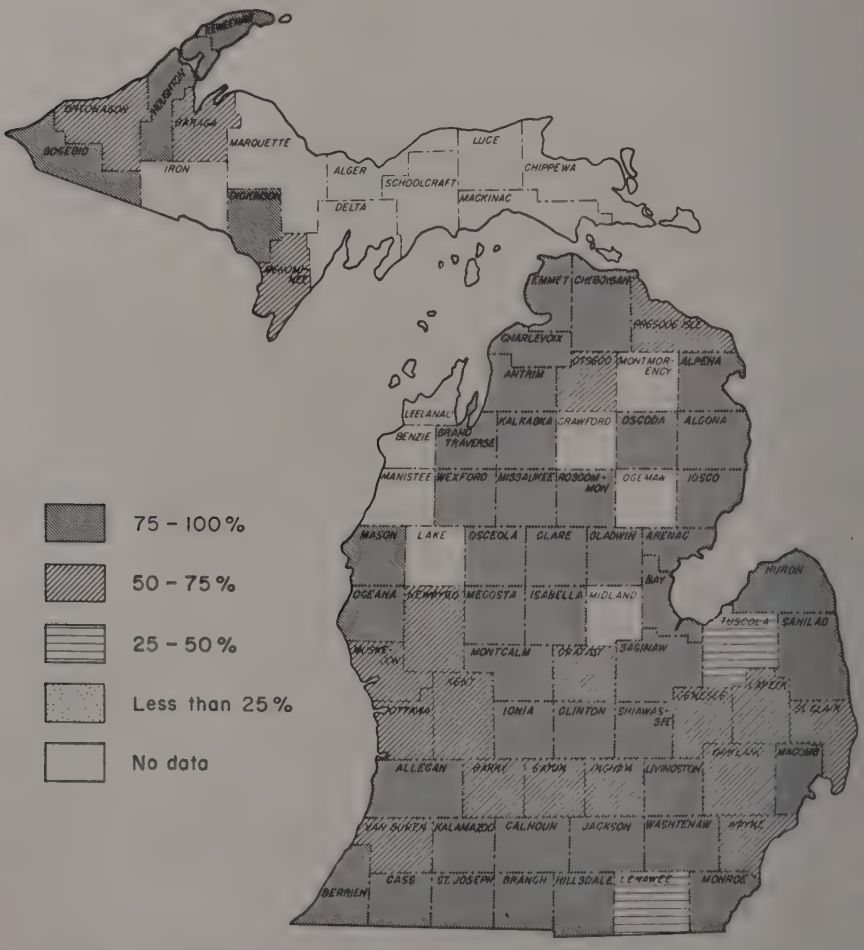

Fig. 5. Percent of soil samples testing medium or low in potassium.

These data illustrate the response that may generally be expected from phosphorus and potassium fertilization. Although they are helpful in planning a soil management program it should be pointed out, as with soil acidity, the data represent large areas. To be certain of the pH, phosphorus and potassium status of any given soil a representative soil sample should be taken to the laboratory for testing.

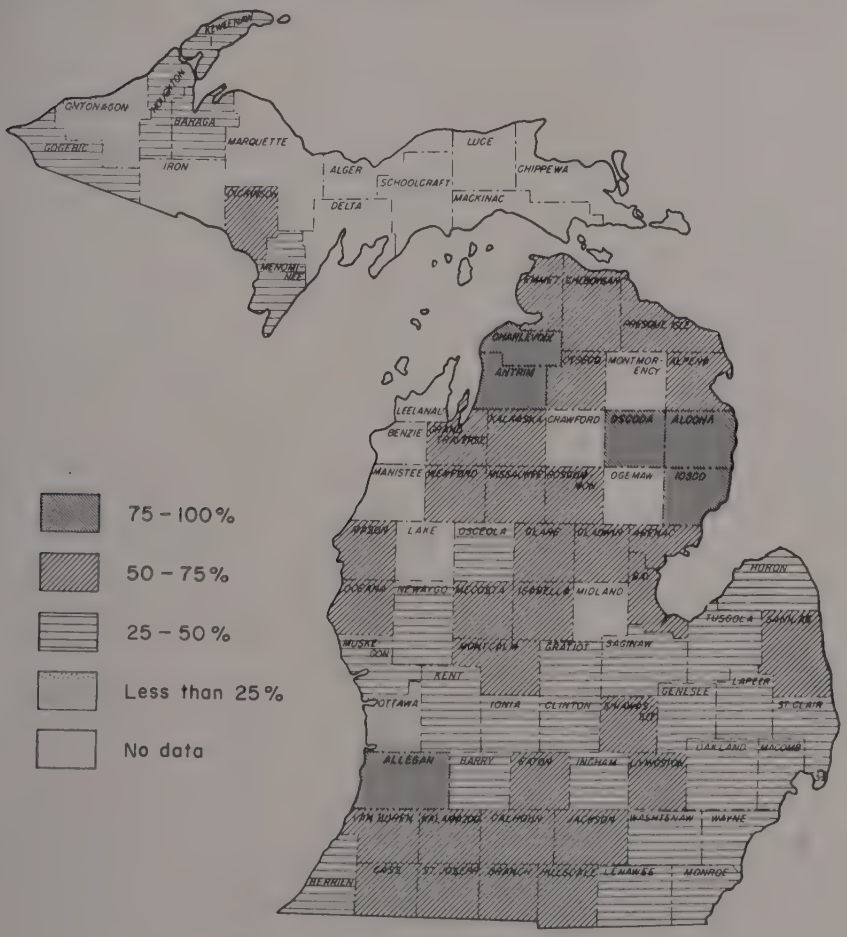

Fig. 6. Percent of soil samples testing low in potassium.

COMPARATIVE QUALITIES OF RECONSTITUTED, CONSUMER-PACKAGED NONFAT DRY MILK AND FRESH FLUID SKIM MILK

By G. M. TROUT, LOUIS JOKAY,[1] and J. R. BRUNNER

Department of Dairy

Consumer acceptance of packaged spray-process nonfat dry milk since World War II has been phenomenal. Undoubtedly, the increased consumer use of this product reflects: 1) emphasis on less fat in the diet; 2) improved product; and 3) economy of product.

The introduction of an "instant" nonfat dry milk in 1954 (Peebles, 1955; 1956) gave impetus not only to the already accelerated sales, but also to research in processing and in the many uses of the more easily reconstitutable product. Preliminary studies on "instant" nonfat dry milk had shown the product to be more miscible than normal spray-dried powder and that some brands at least were very acceptable as a beverage (Trout, 1955, 1956; Trout and Jokay, 1956).

The studies also indicated the need for further investigation to ascertain: 1) the uniformity of the product as store-purchased throughout the year; 2) the relative "solubility" of various manufacturers' products; 3) the organoleptic quality when reconstituted with distilled and/or tap water; 4) the curd tension; and 5) other properties. To this end the studies reported herein were made.

SCOPE OF INVESTIGATIONS

The data reported represent studies on eight commercial, widely distributed, consumer-packaged brands of nonfat dry milk purchased directly from supermarkets monthly throughout a continuous eight-month period. Intermixed with these samples at each time of examination were keyed samples of six different lots of commercially

[1]Presently employed by Quartermaster Food & Container Institute, 1819 West Pershing Road, Chicago 9, Illinois.

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produced fresh skim milk. Thus, the organoleptic study alone involved a total of 64 different samples of nonfat dry milk and 48 samples of fresh skim milk extending throughout the seasons when the cows normally had access to dry vs. green feeds.

A conservative estimate would place the total organoleptic examinations in this study around 1,400. In addition, 128 duplicate analyses and/or observations were made on the curd tension, solubility, stability of foam, plug formation and sediment of the reconstituted product.

PROCEDURE

The samples were reconstituted at the rate of 3.2 ounces per quart using both distilled and tap water at 70° F. A one-quart, polyethylene dry-milk mixer was used as the container for mixing. The powdered product was added to the 60° F. tempered water, allowed to "sink" for 60 seconds, was then stirred gently with a spoon for 30 seconds, after which the "Lac-Mix" shaker was inverted 40 times during a 60- to 80-second period.

The reconstituted nonfat milk was stored in quart milk bottles for 24 hours at 40° F. before examinations. At the end of the storage period, the amount, nature and stability of foam, presence of cream plug and sediment were studied subjectively. Since the presence of any extraneous matter is objectionable in beverage milk, noting the presence, nature and amount of sediment on the bottom of the container was thought to serve the immediate purpose better than making the accepted sediment test on the nonfat dry milk itself.

Following these examinations, a representative 3-ounce sample of each lot was obtained, keyed and assembled for intense flavor study. Each assorted group contained 22 samples consisting of: 1) eight samples of nonfat dry milk reconstituted in distilled water; 2) the same samples reconstituted using tap water; and 3) six samples of natural, fresh, pasteurized skim milk.

Tasting was done according to standard procedure but in addition to noting the flavor, the samples were ranked from one to 22 according to descending flavor quality. After recording the ranks, the cups were reshuffled and again ranked. Odds in selecting the first or last ranking sample would be of the order one to 22. However, duplicating the entire ranking by random selection would have the odds of approximately one to $10^{21} \times 5$. Thus, any semblance of duplication of ranks would lend credence to the method of flavor evaluation.

Portions of the reconstituted samples were stored for 48 hours at 40° F. for curd tension. The hardness of the curd was determined according to the American Dairy Science Association procedure (Doan *et al.*, 1941) using the Submarine Signal Company tensiometer. All curd tension measurements were made in duplicate.

The fat content of the reconstituted nonfat dry milk and of the natural fresh skim milk was determined by the modified Babcock and Mojonnier methods. Total solids of the fresh skim milk was determined by the Mojonnier method.

Solubility of the nonfat dry milk was determined by a specially devised technique which seemed suitable to the current study. The method consisted in reconstituting, sieving, centrifuging, analyzing various portions and making calculations. The method involved the following steps:

1) Weigh out 90.7 g. sample.
2) Temper sample and water to 60° F.
3) Reconstitute to 946 ml. as indicated previously.
4) Filter a 75 ml. sample through a 20-mesh sieve.
5) Put filtrate in Fisher centrifuge bottle and centrifuge 20 minutes in an International, size 2, Model V centrifuge at 2,500 rpm.
6) Pipette 10 ml. from the very top portion of the centrifuge bottle into a Mojonnier total solids dish.
7) Determine percentage of total solids by the Mojonnier method.
8) Calculate the percentage solubility from the weight of nonfat dry milk first reconstituted, the calculation being as follows: Since 90.7 g. of nonfat dry milk were added to sufficient water to make up 946 ml. solution, 1 ml. of the solution theoretically should carry $\frac{90.7}{946}$ or 0.9587 g. of the sample if 100 percent solubility of the dry milk were attained. Thus, a 10-g. aliquot of a perfect solution would contain 9.587 g. of nonfat dry milk. Therefore, the approximate percentage solubility should be indicated by the equation $\frac{\text{T.S. in 10 ml.}}{9.587} \times 100$. On this basis the approximate percentage solubility or relative "instantiety" of solubilities of the various samples were obtained.

RESULTS

Flavor

The flavor of reconstituted and natural skim milk varied markedly among the various samples as well as between the two groups of samples (Tables 1, 2, 3). When the samples were ranked according

TABLE 1—Rank of 22 intermixed samples of reconstituted nonfat dry milk and natural fresh skim milk according to flavor quality

Sample		Reconstituting medium	Placing of 22 intermixed samples of nonfat milk by		
No.	Brand		Judge I	Judge II	Final rating
		RECONSTITUTED NONFAT DRY MILK			
1	A	Tap water	6th	6th	6th
2		Distilled water	10th	17th	14th
3	B	Tap water	11th	5th	9th
4		Distilled water	9th	7th (Tie)	8th
5	C	Tap water	14th	13th	15th
6		Distilled water	20th	14th	17th
7	D	Tap water	18th	12th	16th
8		Distilled water	19th	18th	20th
9	E	Tap water	4th	4th	5th
10		Distilled water	12th	15th	12th
11	F	Tap water	1st	1st	1st
12		Distilled water	3rd	7th (Tie)	4th
13	G	Tap water	15th (Tie)	10th	13th
14		Distilled water	15th (Tie)	20th	19th
15	H(*a*)	Tap water	2nd	2nd	2nd
16		Distilled water	5th	3rd	3rd
		FRESH SKIM MILK			
17	I		21st	21st	21st
18	J		22nd	22nd	22nd
19	K		7th	11th	7th
20	L		8th	16th	11th
21	M		13th	9th	10th
22	N		17th	19th	18th

(*a*) Regular spray process (non-instant).

to organoleptic quality, nonfat dry milk, reconstituted either with tap or with distilled water, commanded the highest ranks in the upper one-third of the composite ranks, as shown by the individual and/or combined judgments of the two judges. In other words, the summary ranking showed that the upper third of the samples were of superior quality.

The samples of this group generally were reconstituted nonfat dry milk. However, in some monthly scorings samples of fresh skim milk occasionally rated in the upper third of the ranks indicating that good quality fresh skim milk was available, but its good beverage quality tended to be inconsistent.

Of the 48 possible placements throughout the eight trials, fresh skim milk ranked seventh or above only 19 times or 40 percent of the cases. One judge placed the natural skim milk in the upper seven places only nine of 24 opportunities or 37.5 percent. On the other hand, of the six samples of fresh skim milk intermixed with the 22 samples judged, both judges rated three, or 50 percent, of them among the lowest ranking third. Composite judgment placed a fourth sample in this category. The composite rankings of the six skim milks among the 22 samples were ninth, 11th, 16th, 19th, 21st and 22nd. Two samples, I and J, were consistently poor throughout the period of study.

Two nonfat dry milks, F and H, were consistently of high beverage quality regardless of the medium of reconstitution. The judges almost invariably rated these samples at the top of the class. Likewise, three nonfat dry milks, C, D, G, secured inferior ratings repeatedly.

The prevailing flavor criticisms of the reconstituted nonfat dry milk were "stale" and "stale powder" whereas those for the fresh skim

TABLE 2—Order of preference of eight brands of reconstituted nonfat dry milk by two judges

Kind of water used for reconstitution	Ranking(*a*) of eight brands of consumer-packaged nonfat dry milk reconstituted with tap or with distilled water, by brands							
	A	B	C	D	E	F	G	H
Distilled	5th	3rd	6th	8th	4th	2nd	7th	1st
Tap	4th	5th	7th	8th	3rd	1st	6th	2nd

(*a*) Relative positions among 22 samples judged as a group by two judges working independently. (Average eight trials.)

TABLE 3—Flavor of reconstituted nonfat dry milk and of commercial-fresh skim milk over an eight-month period

Brand	Kind of water used for reconstitution	Flavor criticisms by months							
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
		RECONSTITUTED NONFAT DRY MILK							
A	Tap	Excl.	Fair.	Sl. heat	Excl.	Good	Good	Fair	Fair
	Distilled	Powd.	Powd.	Sl. heat	Good	Good	Stale	Good	Good
B	Tap	Fair	Good	Sl. heat	Stale	Good	Stale	Fair	Good
	Distilled	Fair	Good	Sl. heat	Stale	Fair	State	Good	Good
C	Tap	Powd.	Powd.	Stale	Flat	Fair	Fair	Poor	Poor
	Distilled	Powd.	Powd.	Stale	Good	Good	Powd.	Poor	Poor
D	Tap	Powd.	Powd.	Stale	Good	Good	Powd.	Poor	Poor
	Distilled	Powd.	Poor	Stale	Stale	Fair	Stale	Fair	Fair
E	Tap	Fair	Good	Sl. heat	Excl.	Good	Fair	Excl.	Good
	Distilled	Fair	Powd.	Stale	Good	Fair	Fair	Good	Good
F	Tap	Good	Excl.	Excl.	Good	Excl.	Good	Excl.	Excl.
	Distilled	Good	Fair	Excl.	Good	Excl.	Good	Excl.	Excl.
G	Tap	Good	Powd.	Stale	Stale	Fair	Powd.	Poor	Poor
	Distilled	Powd.	Powd.	Stale	Stale	Fair	Powd.	Poor	Poor
H	Tap	Fair	Excl.	Excl.	Excl.	Excl.	Excl.	Good	Good
	Distilled	Excl.	Powd.	Excl.	Excl.	Good	Good	Good	Good
		FRESH SKIM MILK							
I		Oxid.	Oxid.	Oxid.	Odix.	Fair	Oxid.	Fair	Fair
J		Oxid.	Oxid.	Oxid.	Oxid.	Oxid.	Oxid.	Oxid.	Oxid.
K		Salty	Good	Salty	Salty	Oily	Fair	Excl.	Good
L		Acid	Good	Salty	Good	Oxid.	Excl.	Salty	Salty
M		Fair	Fair	Sl. heat	Fair	Excl.	Fair	Poor	Poor
N		Fair	Salty	Stale	Oily	Good	Good	Poor	Poor

milk were "oxidized," "salty' and 'oily. The "salty" and "oily" criti-isms were noted in the fortified samples to which nonfat dry milk nd/or mineral and vitamin concentrate may have been added.

The reconstituting medium, tap or distilled water, seemed to in-luence the flavor quality. Of the 128 intermixed samples of recon-tituted nonfat dry milk examined during the eight-month study, udge I and Judge II placed the nonfat dry milk reconstituted with ap water (250 p.p.m. calcium oxids) over the same milk reconstituted vith distilled water 61 and 89 percent of the placings, respectively. If he nonfat dry milk were of excellent quality, the reconstituting me-lium appeared to have had little influence on its beverage quality,

However, if the nonfat dry milk were of poor quality, distilled water as the reconstituting medium seemed to release its off flavor more than did tap water. However, exceptions occurred.

Sediment

The presence of sediment in more or less varying intensity was noted in virtually all samples of nonfat dry milk throughout the study, regardless of the reconstituting medium, (Table 4). The hue of sediment varied in intensity from a deep cream color to a light brown intermixed with black specks.

Stability of Foam

Some degree of foaming seemed to be inherent to reconstitution of nonfat dry milk regardless of the reconstituting medium or method.

TABLE 4—Sediment in nonfat dry milk reconstituted with tap water and in natural fresh skim milk

Sample		Amount(*a*) of sediment noted in samples at trial							
No.	Brand	1	2	3	4	5	6	7	8
		RECONSTITUTED NONFAT DRY MILK							
1	A	—	++	—	++	++	+	+++	+++
3	B	++	+	++	+++	+++	+	++	++
5	C	+	+++	++	+++	+++	++	+++	++
7	D	+++	+	++	+++	+++	+++	++	++
9	E	+	+	—	++	+++	++	+	+
11	F	+	++	+	+++	+++	+++	++	++
13	G	+++	+	++	+++	+++	++	++	++
15	H	+	+	+	+++	+++	+++	+++	+++
		FRESH SKIM MILK							
17	I	—	—	—	—	—	—	—	—
18	J	—	—	—	—	—	—	—	—
19	K	—	—	—	—	—	—	—	—
20	L	—	—	—	—	—	—	—	—
21	M	—	—	—	—	—	+	—	—
22	N	—	—	—	—	—	++	+	—

(*a*) Key: — No sediment.
+ Slight sediment.
++ Distinct sediment.
+++ Very pronounced sediment.

TABLE 5—Foam on nonfat dry milk reconstituted with tap water and on bottled fresh skim milk

Sample		Amount(*a*) of foam (inches) on quart samples after 24 hours at 40° F. as noted in trial							
No.	Brand	1	2	3	4	5	6	7	8
		RECONSTITUTED NONFAT DRY MILK							
1	A	1½	2	1	1½	¾	½	Sl.	Sl.
3	B	½	Sl.	½	½	¼	¾	¼	¼
5	C	—	—	—	—	—	—	—	—
7	D	¾	—	—	—	—	—	—	—
9	E	¼	—	—	½	¼	—	½	½
11	F	½	½	½	¼	Sl.	—	—	—
13	G	—	—	—	—	Sl.	—	—	—
15	H	—	—	½	—	—	—	—	—
		FRESH SKIM MILK							
17	I	—	—	—	—	—	—	—	—
18	J	—	—	—	—	—	—	—	—
19	K	—	—	—	—	—	—	—	—
20	L	—	—	—	—	—	—	—	—
21	M	—	—	—	—	—	—	—	—
22	N	—	—	—	—	—	—	—	—

(*a*) Key: Sl. Slight amount of foam.
— No foam.

But some foams were of short duration. The stability of the foams upon storage varied markedly among the samples (Table 5). Of the eight brands studied, four of them seemed to produce consistently a relatively stable foam. One brand, A, was so conspicuous in this respect that in the first few months of study the sample could be recognized by this characteristic.

The same stable foaming intensity was encountered in this sample whether the nonfat dry milk were reconstituted with tap or with distilled water. Sometimes the foam was so stable and compact, resembling finely beaten eggwhite, that it formed a plug. Generally, however, any tendency toward plug formation was negative.

Four of the samples virtually yielded no foam at 24 hours storage at 40° F. Likewise, the natural skim milk was always free of foam. Undoubtedly, the foaming tendency could be linked with the heat

treatment of the milk prior to drying for there appeared to be a direct correlation between the foaming tendency and the curd tension of the reconstituted milk.

Hardness of Curd

The hardness of curd formed in nonfat dry milk reconstituted with tap water and in natural fresh skim milk, as determined by the tension of the curd, varied markedly (Table 6). The average curd tension of the reconstituted nonfat dry milk ranged from 11 to 31 g. This milk having curd tensions of 33 g. or less may be considered as soft curd (Doan and Welch, 1934; Sommer, 1952). Three nonfat dry milks, A, B, and F, qualify as soft curd by the American Medical Association of 20 g. standard (Amer. Med. Assoc. 1907; Doan *et al.*, 1941).

Natural fresh skim milk exhibited hard curd in virtually all samples. However, some exceptions did occur. The curd-tension values noted

TABLE 6—Curd tension of reconstituted nonfat dry milk and of natural fresh skim milk (average duplicates of eight trials)

Sample		Curd tension (g.) of reconstituted nonfat dry milk and of natural fresh skim milk in trial								
No.	Brand	1	2	3	4	5	6	7	8	Avg.
		RECONSTITUTED NONFAT DRY MILK								
1	A	21.0	12.0	20.0	14.5	15.0	15.0	21.0	5.0	15.3
3	B	17.5	15.5	6.0	5.5	8.5	5.0	14.0	16.5	11.1
5	C	30.5	42.5	30.0	30.0	28.0	25.0	26.0	37.0	31.2
7	D	15.5	25.5	24.5	21.0	32.0	21.5	26.0	26.0	24.0
9	E	23.0	26.0	29.5	31.5	27.5	28.5	36.0	16.5	27.0
11	F	14.0	16.5	15.5	14.0	13.5	12.5	10.0	12.0	13.5
13	G	14.5	26.0	21.5	25.0	23.5	20.0	16.5	18.5	20.8
15	H	19.5	29.0	15.5	18.0	20.0	19.5	20.5	13.5	19.4
		SKIM MILK								
17	I	41.5	45.0	44.5	40.0	55.0	52.5	44.0	59.5	47.2
18	J	37.0	40.0	50.0	44.0	42.0	35.0	35.0	44.0	40.8
19	K	44.5	40.5	44.0	47.0	67.5	55.0	45.0	64.0	50.9
20	L	45.0	57.5	44.0	40.0	71.5	62.5	57.5	57.5	54.4
21	M	42.5	52.5	42.5	47.5	41.0	30.0	47.5	57.5	45.1
22	N	30.0	5.0	35.0	24.5	37.5	38.5	40.0	16.0	28.3

TABLE 7—The fat content of reconstituted nonfat dry milk and of natural fresh skim milk as determined by the modified Babcock method

Sample		Fat test (%) of reconstituted nonfat dry milk and of natural fresh skim milk in trial								
No.	Brand	1	2	3	4	5	6	7	8	Avg.
		RECONSTITUTED NONFAT DRY MILK								
1	A	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	—
3	B	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	—
5	C	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—
7	D	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	—
9	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	—
11	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—
13	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—
15	H	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—
		FRESH SKIM MILK								
17	I	0.01	0.01	0.01	0.09	0.01	0.10	0.08	0.02	0.04
18	J	0.02	0.08	0.06	0.04	0.04	0.02	0.02	0.03	0.03
19	K	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.01
20	L	0.09	0.02	0.02	0.01	0.05	0.12	0.13	0.05	0.06
21	M	0.06	0.05	0.03	0.02	0.02	0.04	0.15	0.20	0.07
22	N	0.57	0.07	0.28	0.43	0.80	0.58	0.36	0.36	0.41

on the fresh skim milk in this study were much lower than the 77, 79, and 70 g. curd tension on raw skim observed by Palmer and Tarassuk (1940) and slightly lower than the 56 g. reported by Sanders *et al.* (1936). Several factors are known to affect curd tension (Doan, 1938).

Duplicate trials were run also using distilled water as the reconstituting medium. Little differences were encountered in data obtained from those reported in Table 6.

Fat Content

The fat content of reconstituted nonfat dry milk, as determined by the modified Babcock method, was virtually zero in all trials of all brands (Table 7). Similar fat tests on natural fresh skim milk always revealed the presence of fat. The percentage fat was found to range from 0.01 percent to 0.57 percent. Six samples of fresh skim milk, I, J, K, L, M, and N, averaged 0.04, 0.03, 0.01, 0.06, 0.07, and 0.41

percent fat, respectively, when tested by the modified Babcock method. These same samples averaged 0.16, 0.13, 0.15, 0.29, 0.29, and 0.58 percent fat, respectively, when tested by the Mojonnier method.

Total Solids

Inasmuch as the nonfat dry milk was reconstituted on the basis of 3.2 ounces per quart of water and should, therefore, yield the same percentage of total solids, such analyses were not run on the reconstituted milk. The total solid values of the fresh skim milk were determined. The percentages are recorded in Table 8.

Three samples, K, L, and N, were purchased as "fortified" skim milk. Analysis showed these samples to contain from approximately 1.25 to 2.50 percent added nonfat dry milk. Referring back to Table 3, these samples were the ones criticized occasionally as having a "salty" flavor, a flavor resulting when additional nonfat dry milk is added to skim milk in too large quantities.

TABLE 8—Total solids of natural fresh skim milk

Trial	Total solids (%) of natural fresh skim milk from dairy					
	I	J	K(*a*)	L(*a*)	M	N(*a*)
1.....	(lost)	9.13	10.51	11.60	8.82	10.51
2.....	9.18	8.68	10.17	11.32	9.09	10.46
3.....	9.03	9.22	10.17	10.87	9.42	10.98
Average.. .	9.11	9.01	10.28	11.26	9.11	10.64

(*a*) Fortified.

Relative Solubility

The percentage of nonfat dry milk in solution, as determined immediately after mixing, varied among the different makes of powder (Table 9). One brand, A, was comparatively insoluble, averaging 82.50 percent in solution and ranged during the course of the study from 75.59 to 92.84 percent, the last trial. Another brand, B, fluctuated in its solubility from 85.53 to 92.04 percent, averaging 89.04 percent. The other brands not only were more consistently soluble, but more highly soluble as well.

Sixty-seven percent of the 64 samples tested exhibited solubilities within the 91 to 95 percent range (Table 10). Few of the samples exhibited solubilities during the study greater than 95 percent.

TABLE 9—Percentage of nonfat dry milk in solution (relative solubility) immediately after reconstitution in tap water

Sample		Percentage of nonfat dry milk in solution immediately after reconstitution in trial								
No.	Brand	1	2	3	4	5	6	7	8	Avg.
		%	%	%	%	%	%	%	%	%
1	A	84.1	75.6	82.7	80.3	82.9	79.4	87.0	92.8	82.5
2	B	85.9	90.0	89.6	89.1	87.7	85.5	92.0	89.0	89.0
3	C	93.1	93.2	91.3	91.9	91.3	92.6	90.6	92.8	92.1
4	D	92.8	92.3	94.0	94.2	93.2	96.7	94.1	93.3	92.3
5	E	90.1	91.6	93.0	92.0	92.0	91.7	94.1	93.3	92.3
6	F	93.8	92.2	90.9	99.4	91.1	97.4	92.2	91.5	92.7
7	G	94.4	91.5	93.1	92.0	91.4	92.0	96.9	93.3	92.8
8	H	90.4	93.0	92.0	92.2	90.9	94.6	94.5	92.5	92.5

Shelf Life

No detailed extensive studies were made of the shelf life of the nonfat dry milk under study. Nevertheless, the dry products were stored at 40° F. for 24 months to ascertain if the powder had retained its freshness and if upon reconstitution, any appreciable beverage quality remained. Unfortunately, none of the powders retained their good properties over this period, although the stale, off flavor common to them did vary somewhat in intensity.

TABLE 10—Percentage distribution of solubilities of various samples of nonfat dry milk

Range (%)	Distribution of samples of nonfat dry milk as to their solubilities	
	Number	Percent
Less than 80	3	4.7
80 to 84	5	7.8
85 to 89	10	15.6
90 to 94	43	67.2
95 to 100	3	4.7
Total	64	100.0

DISCUSSION

Marked improvement seems to have been made in the manufacture of nonfat dry milk since these studies were first undertaken several years ago. In fact, during the period of this study, some changes toward the betterment of the product were noted in one of the brands.

Perhaps, some inconsistencies noted in respect to certain factors might be attributed, in part, to the fact that commercial manufacture of some of the nonfat dry milk was yet in the experimental or pilot laboratory stage. Competition forced keeping products before the public despite the fact that the acme of perfection in manufacture had not yet been attained.

That manufacturers are well aware of the excellencies and/or deficiencies of competitors' products is beyond question. While this study was in progress, the workers were conscious of impending introduction of improved products under certain brands. Such has since become a reality. If anything, this study points to the necessity of knowing intimately the various brands, their merits and shortcomings in order to understand ably and to advise intelligently major trends within the industry.

"Instantization" seems to have overcome the former difficult miscibility problem. While perhaps minor, other problems seem to press for solution. Foaming, especially the more persistent types are tolerated, but not desired. Likewise, sedimentation needs complete elimination. Natural fresh skim milk is notably free from distracting foreign specks which seemed to be quite prevalent in the reconstituted nonfat dry milk.

Rating of brands F and H consistently among the top samples, if not at the top, of the 22 lots examined, speaks well for the superior quality of those products. Interestingly, one of these samples was regular spray dried, indicating possibly that the key to quality of finished product was not associated wholly with the "instantizing" process. Perhaps the companies manufacturing these brands were conscious of shelf life and the flavor-deteriorating effect of uncontrolled storage and consequently exerted effort to keep only relatively fresh nonfat dry milk on the supermarket shelves. In this study, the nonfat dry milk was purchased regularly each month. No attempt was made to ascertain the age or conditions under which the products were kept.

Again, the study shows the necessity of concerted effort to improve the beverage quality of natural fresh skim milk. Flavor problems inherent to a nonhomogenized product must be overcome if increased repeated sales are to be expected. In this study some of the fresh beverage skim milk was of poor flavor quality, consistently placing at the bottom of the class.

The virtually complete lack of fat in reconstituted nonfat dry milk as determined by the modified Babcock method seems out of order. Yet, the same test always revealed fat in the fresh skim milk. Perhaps the rigorous physical and temperature treatment incident to concentrating and drying skim milk would be sufficient to disintegrate or render innocuous the less than 0.02 percent of fat remaining in efficiently separated milk. The anomaly needs enlightenment. The data substantiate the inadequacy of the Babcock method for determining the fat of reconstituted nonfat dry milk.

SUMMARY

Eight commercial, consumer-packaged nonfat dry milks were studied monthly over a period of eight months. Included also were six commercial samples of natural fresh skim milk. The studies included: 1) flavor; 2) sediment; 3) stability of foam; 4) hardness of curd; 5) fat content; 6) total solids; and 7) relative solubility.

The flavor both of reconstituted nonfat dry milk and of natural fresh skim milk varied markedly throughout the study. Two brands of nonfat dry milk consistently had a superior flavor rating.

Sediment was noted in reconstituted nonfat dry milk, but was absent in the natural fresh skim milk.

Reconstituted nonfat dry milk curd was softer than that of fresh skim milk, the latter being relatively hard in comparison. Several brands of nonfat dry milk yielded soft curd as judged by the prevailing standards.

Approximately 92 percent of the nonfat dry milks were in solution when the tests were run immediately after reconstitution. One brand exhibited materially less solubility than the others.

Stable foam formation in reconstituted nonfat dry milk was the exception rather than the rule.

LITERATURE CITED

American Medical Association (Council on Foods) (1937). The nutritional significance of the curd tension of milk. Jour. Amer. Med. Assoc. 108: 2040; and 108: 2122.

Doan, F. J., and R. C. Welch (1934). Soft-curd milk. Pa. Agr. Expt. Sta. Tech. Bul. 312. 35 pp.

Doan, F. J. (1938). Soft curd milk. A critical review of the literature. Jour. Dairy Sci. 21: 739-756.

Doan, F. J. *et al.* (1941). Final report of committee on methods of determining the curd tension of milk. Jour. Dairy Sci. 24: 825-827.

Palmer, L. S., and N. P. Tarassuk (1940). Physical and chemical properties of the fat globule adsorption "membrane." II. Nature and origin of surface active materials involved in curd tension reduction and prevention of rennet clot of cow's milk by "membranes" from natural and synthetic creams. Jour. Dairy Sci. 23: 861-871.

Peebles, D. D. (1955). The Peebles instant milk process. (Abst.) Tech. Program and Absts., 15th Ann. Meeting Inst. Food Technol. p. 21.

Peebles, D. D. (1956). The development of instant milk. Food Technol. 10: 64-65.

Sanders, G. P., K. J. Matheson, and L. A. Burkey (1936). Curd tension of milk and its relationship to firmness of curd in cheesemaking. Jour. Dairy Sci. 19: 395-404.

Sommer, H. H. (1952). *Market Milk and Related Products.* 3rd ed. 750 pp. Author: Madison, Wis. p. 517.

Trout, G. M. (1955). Reconstituted, concentrated and dried milk products and sterilized milk. Proc. 48th Ann. Conv., Milk Indus. Found., Lab. Sect. pp. 82.

Trout, G. M., and L. Jokay (1956). The beverage quality of reconstituted nonfat dry milk. Mich. Agr. Expt. Sta. Quart. Bul. 38: 450-459.

Trout, G. M. (1956). Current developments in the manufacture and use of nonfat dry milk. Proc. XIVth Internatl. Dairy Cong. I part 2, pp. 498-503.

THE STRENGTH OF GLUE JOINTS IN WOOD OBTAINED WITH MINIMUM GLUE SPREAD

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INTRODUCTION

GLUE SPREAD is the amount of adhesive used for the lamination of two adherents, usually expressed as the ratio of adhesive weight to unit surface area. A reduction of the glue spread beyond certain minimum values generally results in decreasing joint strength.

The minimum glue spread necessary for obtaining optimum joint strength depends upon certain conditions of the adherents and will be different for any particular gluing problem. Considering the case of wood gluing, it will be found that the surface characteristic of wood is one of the conditions contributing to a reduction in joint strength with diminishing glue spread.

If the surface area of one plane of each of two adherents is defined as the product of the dimensions a and b, the total surface area involved in the gluing process would be $A = 2\ ab$. This expression, however, is an approximation since it does not take into account the characteristics of the surface, which might be smooth, rough or porous. Considering the area of contact A_c resulting when the two surfaces are brought together, it is found that the ratio of contact, $C = \frac{A_c}{A}$ is equal to ½ only when the two surfaces are absolutely smooth and plane.

In this particular case, the thickness of the glue line could be reduced substantially without loss of joint strength. The minimum glue spread required for efficient gluing would be relatively small and would be determined by the amount of glue necessary to produce a continuous film. If, however, the surfaces are uneven, the ratio of

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contact is smaller than ½ and a reduction of glue spread will eventually result in open gaps and loss of strength. In this instance, the minimum glue spread required for efficient gluing would depend upon the surface characteristic of the adherent.

It therefore seems obvious—from the standpoint of adhesive consumption—that for a given quantity of adhesive the gluing conditions should improve with increase in the ratio of contact between wood surfaces.

The glue line in particle boards

Particle board is a lamination of thin shavings of varying sizes and shapes. Prior to lamination in a hot press, the particles are coated with adhesive by means of a spraying device (usually air spray).

The adhesive consumption is generally expressed as per cent of solid adhesive used based on the dry weight of the wood particles. The glue spread can be calculated by using the following formula:[1]

$$G = \frac{G_1}{A} \quad \text{where } A = \frac{0.2}{r_o\, t}$$

G = Glue spread (g/m^2)
G_1 = Percentage of solid glue on dry wood (g/100g)
A = Flake surface area per 100 g of dry wood (m^2/100g)
r_o = Specific weight of oven dry wood (g/cm^3)
t = Thickness of Flakes (mm)

This relation is demonstrated for a flake thickness of 0.01 inch in Fig. 1. The calculated glue spread is the coverage of the flakes. Since it is assumed that all flakes are uniformly coated, the amount of adhesive per glue line would be twice the glue spread.

According to Fig. 1, the glue spread in a Douglas fir flake board using 6 percent solid adhesive would be about 0.35 g/ft^2 and the amount of adhesive per glue line would be 0.7 g/ft^2. For the glue line in a Douglas fir plywood, the adhesive consumption runs as high as 10 to 12 g/ft^2 solid adhesive or 14 to 17 times as much as in the flake board. The strength of the flake board, although not as high as that of plywood is considerable. (Modulus of rupture: 3000 to 6000 psi)

It can be concluded that the gluing conditions in a flake board must be quite different from those prevailing in the manufacture of plywood.

[1] Untersuchungen über die Eignung von verschiedenen Holzarten insbesondere von Rotbuchenholz zur Herstellung von Holzspanplatten. W. Klauditz, Bericht 25/52 des Institutes fuer Holzforschung T. H. Braunschweig, 1952.

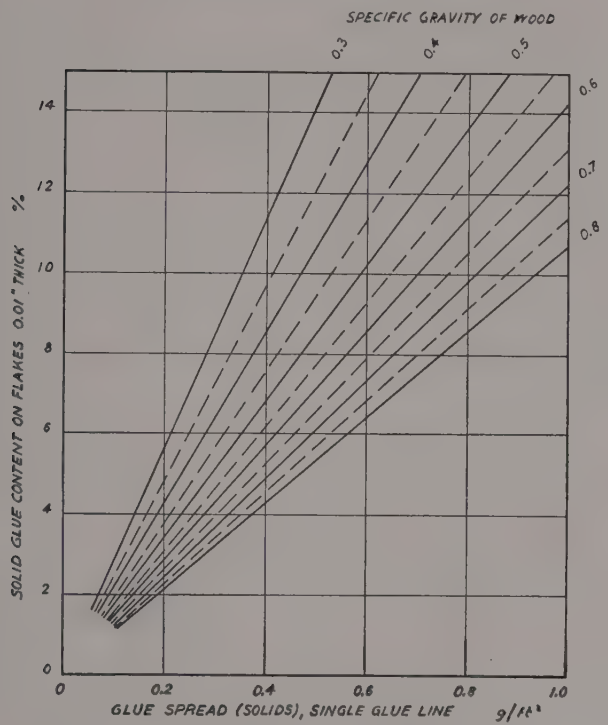

Fig. 1. Relationship between solid glue content of .01 inch thick flakes expressed as percentage of dry wood and actual glue spread for varying specific gravity of wood. (The specific gravity expressed throughout this paper is based on oven dry weight and oven dry volume.)

It is believed that the following two characteristics of a flake board are responsible for the improved gluing conditions:

a) Flexibility of thin laminas

b) Uniform distribution of glue line pressure due to high rate of compression

Both factors are likely to result in an increased rate of contact.

Objective

It is the objective of this study to produce, test, and evaluate the quality of glue bonds similar to those prevailing in the manufacture of flake boards.

EXPERIMENTAL PROCEDURES

The characteristics of the glue lines in particle board were approached by using the following technique:

A) Application of adhesive by air spray

B) Lamination of thin veneers (1/28") under uniform pressure (rubber cushion).

The strength of the glue lines was tested by standard shear test.

Application of adhesive and determination of glue spread

The binder in particle board manufacture is usually applied in diluted form. This form of application makes the direct determination of the actual glue spread by weighing very difficult, because the concentration of the adhesive will continuously vary from the time it leaves the spray nozzle until the weighing can be undertaken.

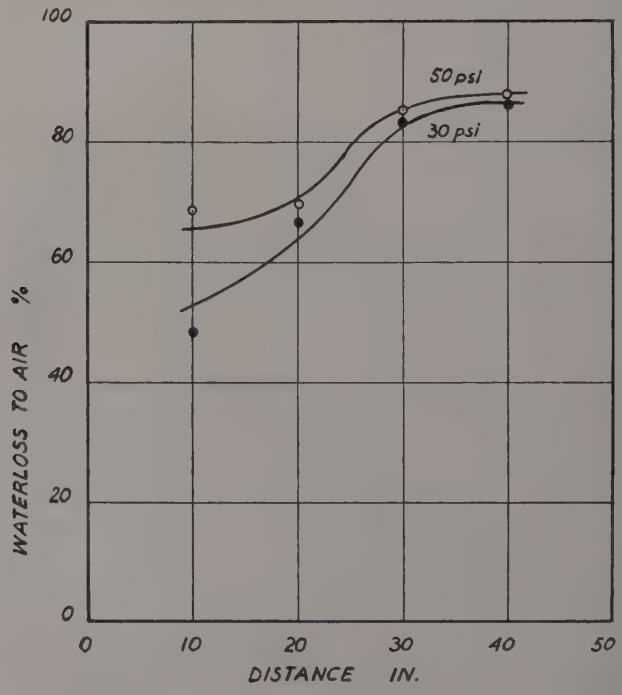

Fig. 2. Water-loss of diluted adhesive during spraying operation shown as a function of spraying distance. Adhesive: Urea formaldehyde, initial solids content 50 percent.

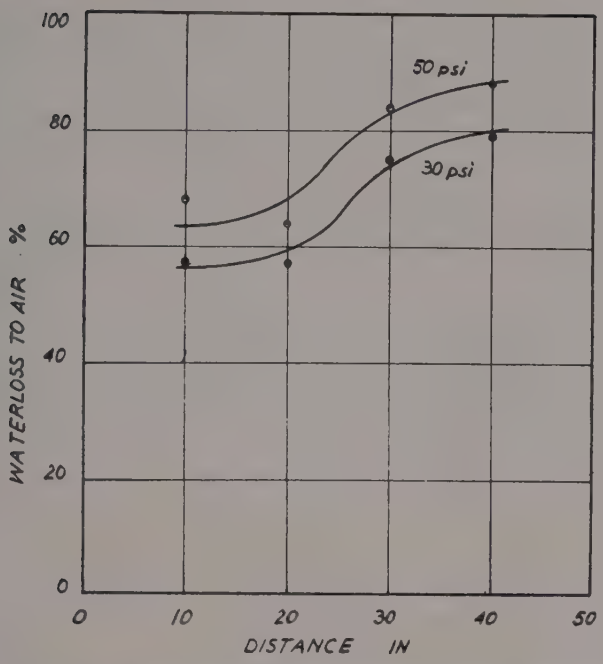

Fig. 3. Water-loss of diluted adhesive during spraying operation shown as a function of spraying distance. Adhesive: Urea formaldehyde, initial solids content 30 percent.

It follows that for an exact determination of the glue spread by eighing, the concentration of the adhesive at the time of weighing ust be known.

Tests conducted in that direction, using a regular paint spray un, did not render results accurate enough to serve as the basis for lue spread determination. Nevertheless, some of the findings are resented here to demonstrate the water-loss during the spraying rocess. The adhesive was sprayed on aluminum sheets of known eight which were weighed immediately after spraying and again fter drying.

Fig. 2 shows the water-loss of an adhesive with an initial solid ontent of 50 percent as a function of spraying distance.

Fig. 3 shows the same relation for an adhesive having an initial oncentration of 30 percent solids.

It can be concluded that part of the solvent is lost in the atomizing rocess and that more water is lost during the travel through the air.

A hypothetical picture of the situation is given in Fig. 4. If these curves could be established with reasonable accuracy, the concentration of the adhesive on the wood could be calculated and the actual glue spread could be determined by weighing, assuming that the remaining solvent would be absorbed by the wood.

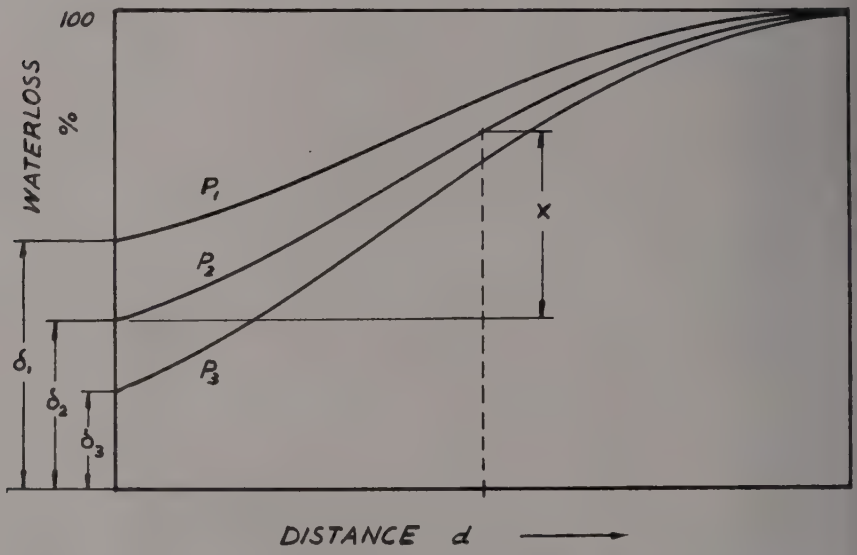

Fig. 4. Hypothetical picture of water-loss during spraying operation shown as function of spraying distance.

$P_1 > P_2 > P_3$
δ = initial water-loss during atomization in spray nozzle
x = water-loss during travel through air.

In the experiments presented in this study, an indirect method for determining the glue spread was employed:

Step 1: Two specimens to be laminated (3″ x 3″ squares of 1/28″ thick veneer) and three glass microslides (3″ x 1″) were arranged in a manner illustrated in Fig. 5. The weight of each microslide had previously been determined to the nearest 1/10,000 g.

Step 2: Diluted adhesive (50 percent solids) was applied to this arrangement with a spray gun by passing the spray over the specimens at uniform speed and at uniform distance (20″).

Step 3: The veneers were laminated in a hot press.

Step 4: The microslides were oven-dried and then weighed again to the nearest 1/10,000 g.

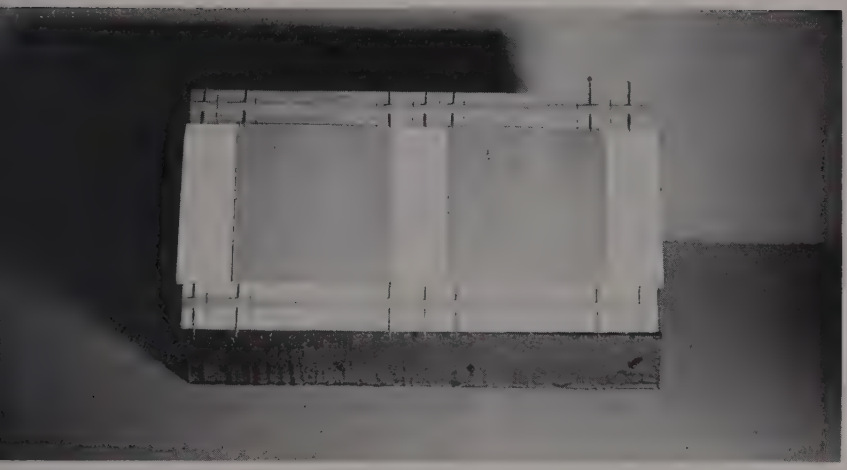

Fig. 5. Arrangement of micro-slides and veneer samples for glue application by spraying.

Step 5: The average glue spread per 3 sq. in. was found as follows:

$$\bar{x} = x_1 + x_2 + x_3 \pm t \frac{s}{\sqrt{n}} \sqrt{1 - \frac{n}{N}}$$

Where $\bar{x}$ = Average glue spread (solids) on 3 sq. in.
x_i = Amount of solid glue found per glass slide
n = Size of sample (3)
N = Size of population (9)

$$s = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}}$$

$t = 4.30$ (95%)

This can be rewritten as:

$\bar{x} \pm s \times 2.03$ for a probability of 95%.

The glue spread in g/ft² could then be found from a graph shown in Fig. 6. Table 1 is an example of the results obtained by this method.

Lamination and preparation of test specimens for shear test.

Immediately after spray coating the veneers were laminated in a 6″ by 6″ hot press. To provide for the cushion effect existing in the pressing of particle board, a ⅛″ thick, soft, rubber pad was used on one side.

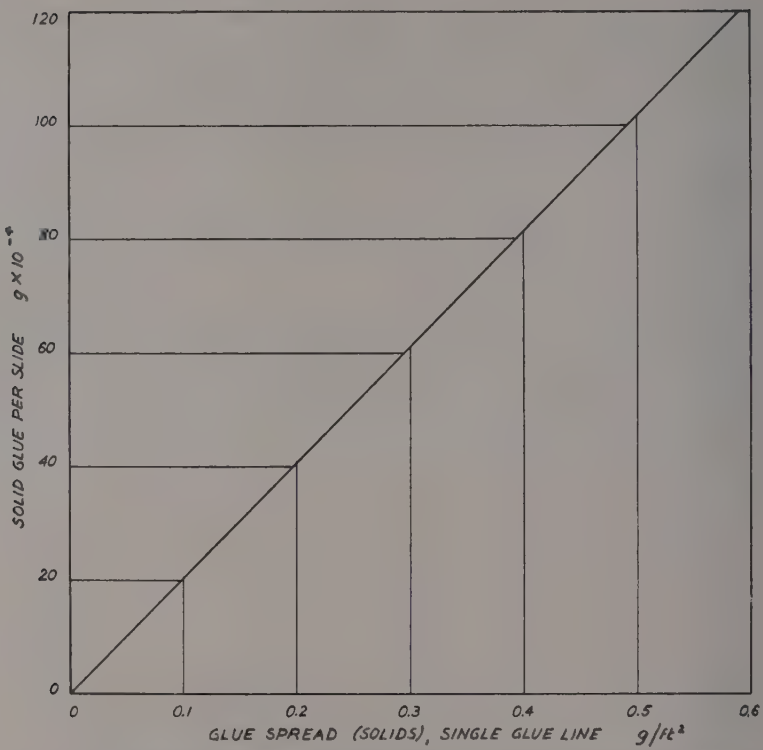

Fig. 6. Relation between glue spread per micro slide and glue spread per square foot.

Actual size of micro slide: 75 x 25mm²

TABLE 1—Example of calculation of average glue spread

Sample No.	Slide No.	Weight of slide dried g	Weight of slide coated and dried g	Solid glue per slide g×10⁻⁴	$\bar{x}$	$(x_i-\bar{x})^2$	$\frac{\Sigma(x_i-\bar{x})^2}{2}$	s	s×2.03	Average glue spread g/ft.²
1	1	4.8782	4.8892	110	118	64	46.5	6.8	13.8	0.585±11.7%
	2	4.7771	4.7891	120		4				
	3	4.8701	4.8824	123		25				
2	4	4.8440	4.8654	214	213	1	37.5	6.1	12.4	1.055±5.8%
	5	4.9904	5.0110	206		49				
	6	4.7356	4.7574	218		25				
3	7	5.0172	5.0470	298	290	64	112.0	10.6	21.5	1.435±7.4%
	8	4.4323	4.4601	278		144				
	9	4.6749	4.7043	294		16				
4	10	4.7809	4.8068	259	256	9	313.0	17.7	36.0	1.267±14.1%
	11	4.8456	4.8693	237		361				
	12	5.0859	5.1131	272		256				

The shear test specimens were obtained by reinforcing the veneer laminates with ¾″ oak as illustrated in Fig. 7.

After conditioning, two shear specimens were cut from each sample. The shear tests were conducted on a Baldwin Emery Testing Machine using the ASTM Block Shear Tester.

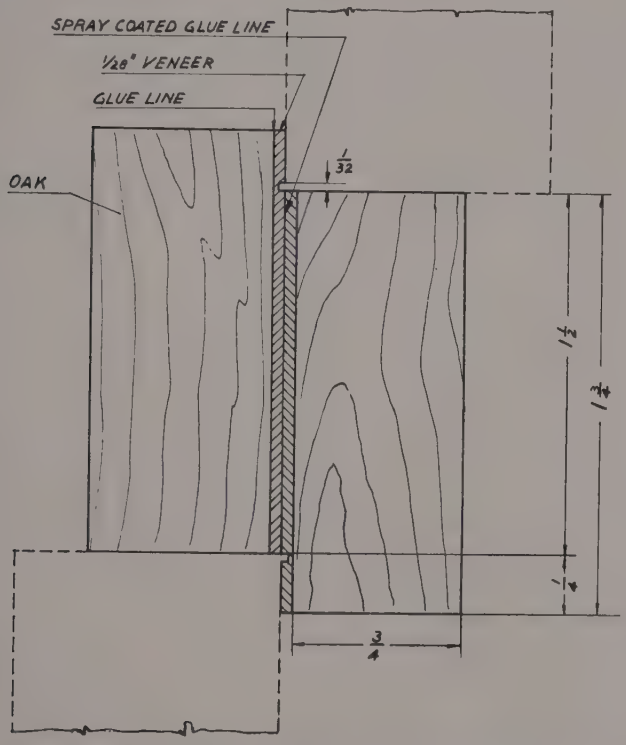

Fig. 7. Shear test specimen for testing spray coated glue lines. Shear area: 1½″ x 1″ = 1.5 in.²

Variables included in investigation

The following variables were included in this investigation:

a) Glue spread
b) Specific gravity of the laminates
c) Moisture content of laminates prior to application of adhesive
d) Laminating pressure

RESULTS

Effect of glue spread and specific gravity of wood on shear strength of glue joints

Both veneers were coated with adhesive. In the diagrams, (Figs. 8 and 9) the glue spread is expressed in g/ft² per glue line. The equivalent glue spread which would have been used in a flake board consisting of flakes 0.01" thick and of the same specific gravity is given in percent based on the weight of oven dry wood.

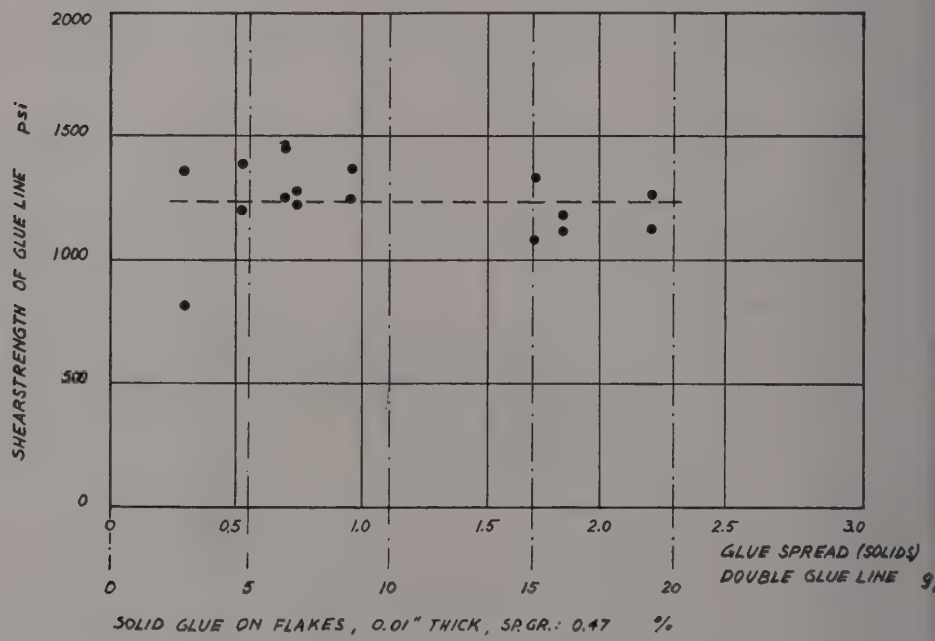

Fig. 8. Shear strength of glue line as a function of glue spread.

Species:	Prima Vera, sliced
Specific gravity:	0.47
Veneer thickness:	1/28"
Moisture content:	9.7% prior to spraying
Adhesive:	Urea formaldehyde (66% solids, diluted to 50%) double spread
Air Pressure:	20 psi
Spraying distance:	20 in.
Laminating pressure:	150 psi
Press temperature:	300°F
Press time:	5 min.

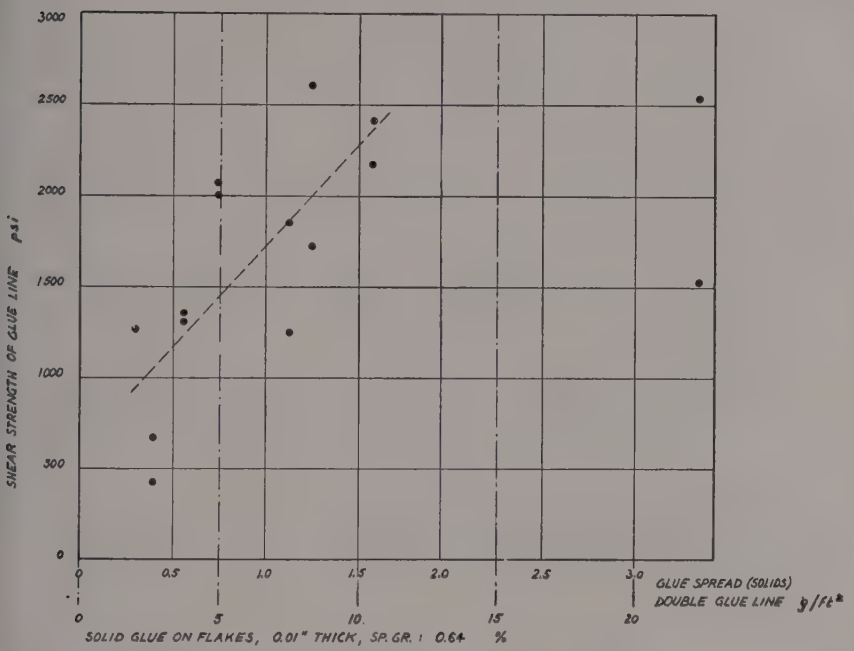

Fig. 9. Shear strength of glue line as a function of glue spread.

Species:	Ash, sliced
Specific gravity:	0.64
Veneer thickness:	1/28″
Moisture content:	9.3% prior to spraying
Adhesive:	Urea formaldehyde (66% solids, diluted to 50%) double spread
Air pressure:	20 psi
Spraying distance:	20 in.
Laminating pressure:	150 psi
Press temperature:	300°F
Press time:	5 min.

a) Specific gravity 0.47 (Prima Vera)
   1. Shear failure occurred in all cases in the veneer.
   2. There is no correlation between glue spread and shear strength in the range tested ($r = -0.0114$).

b) Specific gravity 0.64 (Ash)
   1. Shear failure occurred in nearly all cases in the glue line.
   2. The correlation between glue spread and shear strength is significant in the range from minimum glue spread up to about 1.5 g/ft² ($r = 0.755$).

Single spread versus double spread

In this series only one of the two veneers was spraycoated. In Figs. 10 and 11 the results are compared with those of the preceding series.

a) Specific gravity 0.48 (Prima Vera)
   1. Shear failure occurred in all cases in the veneer.
   2. There is no significant correlation between glue spread and shear strength in the range tested ($r = 0.41$)

b) Specific gravity 0.66 (Ash)
   1. Shear failure occurred in nearly all cases in the glue line.
   2. The correlation between shear strength and glue spread is significant in the range tested ($r = 0.446$)

Comparing the two series (single spread versus double spread) it was found that the differences for both species are not significant.

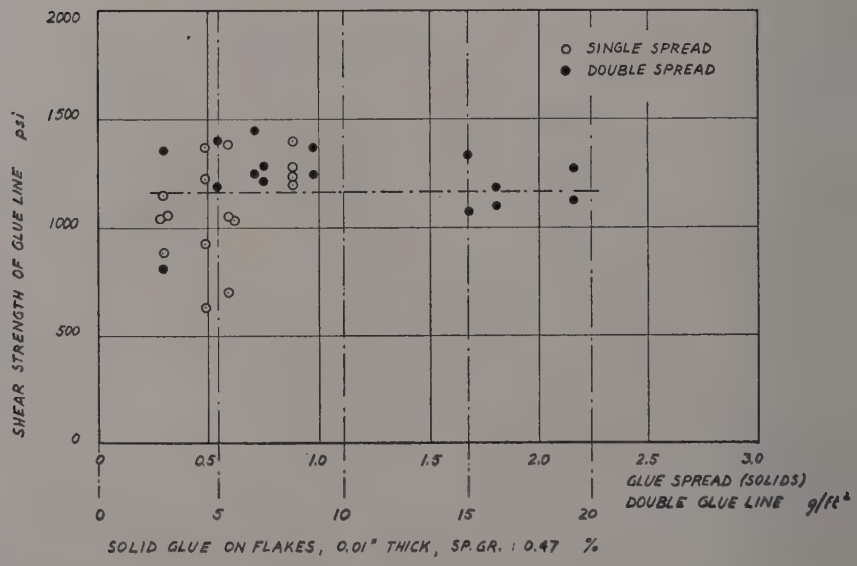

Fig. 10. Shear strength of glue line as a function of glue spread. Comparison single spread versus double spread.

Species:	**Prima Vera**
Conditions:	**Same as in Fig. 8**

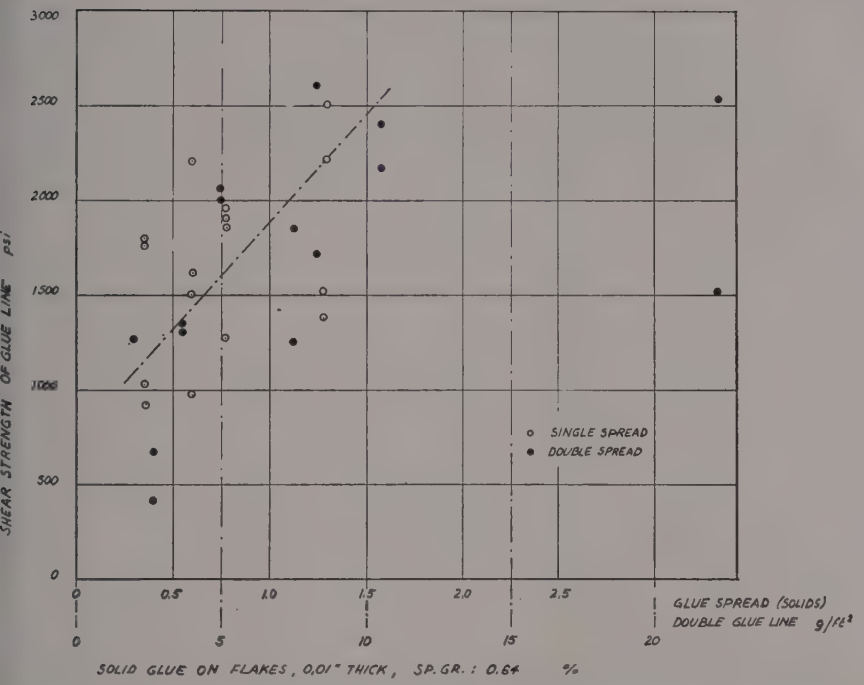

Fig. 11. Shear strength of glue line as a function of glue spread. Comparison single spread versus double spread.

Species:	**Ash**
Conditions:	**Same as in Fig. 9**

Effect of moisture content of laminas prior to spray coating and of laminating pressure on shear strength of glue joint

The design and the results of this experiment are illustrated in Table 2. The variables are:

four different moisture contents
three different pressures
two different glue spreads

Species: Yellow Birch, specific gravity: 0.64

Only two of the three variables could be confined to definite levels. Since the glue spread could not be controlled directly and could be determined only after the veneers had been laminated, the design lacks accuracy. This fact is reflected in the difficulty of statistical analysis. As shown in Table 2, there are four laminations at different glue levels for each of the three

TABLE 2—Effect of moisture content, laminating pressure and glue spread on shear strength. Design and results of experiment

Moisture Content percent	Pressure p.s.i.	Glue spread gs./ft.²	Shear strength p.s.i.	Moisture content percent	Pressure p.s.i.	Glue spread gs./ft.²	Shear strength p.s.i.
23.7	300	1.67	330	8.4	300	2.01	2,390
		1.52	640			1.02	2,250
		0.47	370			0.98	2,395
		0.66	0			0.39	1,680
	200	1.08	740		200	1.22	1,960
		1.41	1,080			1.45	2,080
		0.55	280			0.94	1,780
		0.33	340			0.85	2,140
	100	1.41	720		100	1.43	1,940
		2.50	1,110			1.11	1,800
		0.55	560			0.68	1,560
		0.61	840			0.58	1,510
16.0	300	0.96	1,410	0.4	300	2.03	1,040
		1.32	1,180			2.07	1,600
		0.45	1,090			1.04	710
		0.28	940			0.59	640
	200	1.03	1,110		200	2.27	1,610
		0.85	1,430			1.72	1,330
		0.25	420			0.67	1,260
		0.32	650			0.56	770
	100	1.15	1,870		100	2.09	1,370
		1.08	1,320			1.87	930
		0.81	1,490			0.59	810
		0.56	1,150			0.98	740

pressure groups in each M.C. (moisture content) series. It was intended to apply the same amount of adhesive to each two of the four samples, one pair having a low glue spread and the other pair having a high glue spread. The lower glue spread was intended to be around 0.5 g/ft²; the higher glue level around 1.5 g ft². The table shows that the actual glue spread varies

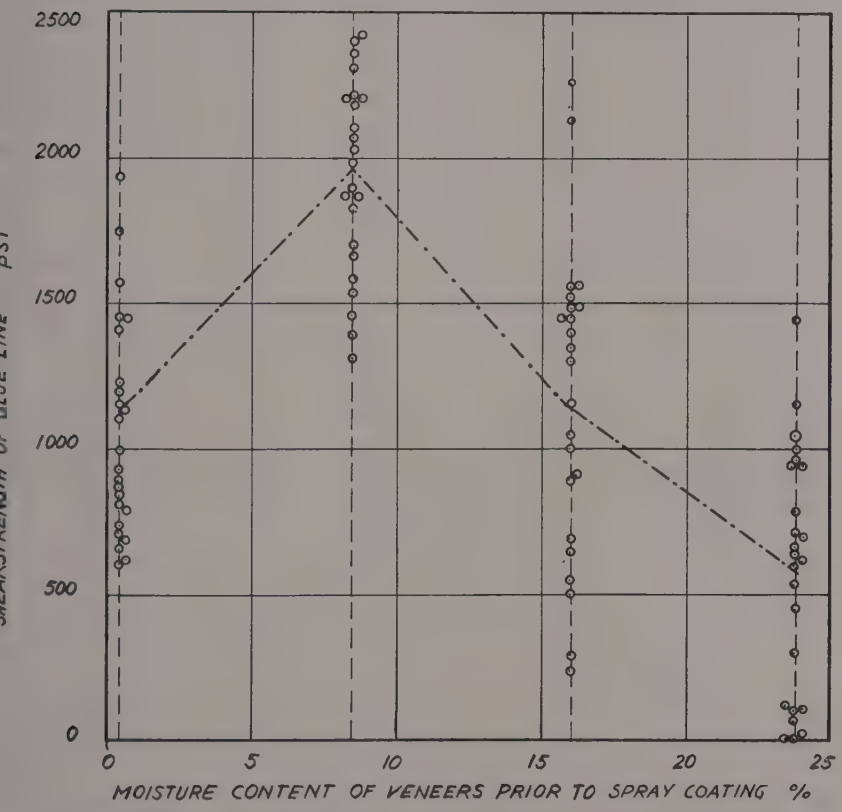

Fig. 12. Shear strength of glue line as a function of moisture content, disregarding effect of laminating pressure and glue spread.

Species:	Yellow Birch, sliced
Specific gravity:	0.64
Veneer thickness:	1/28″
Adhesive:	Urea formaldehyde (66% solids, diluted to 50%) double spread
Air pressure:	20 psi
Spraying distance:	20 in.
Press temperature:	300°F
Press time:	5 min.

from those predetermined values. There is in fact some overlapping.

For those reasons, the design was broken down into four two-factor analysis of variance, in order to reduce the overlapping of the glue spread, especially as the effect of the moisture content on joint strength is rather pronounced in all cases.

a) Effect of moisture content on joint strength

This factor was not analysed. However, the effect of the moisture content is very pronounced as shown in Fig. 12, 13, 14, and 15. The optimum value, between 0 percent and 16 percent, is probably around 8 percent.

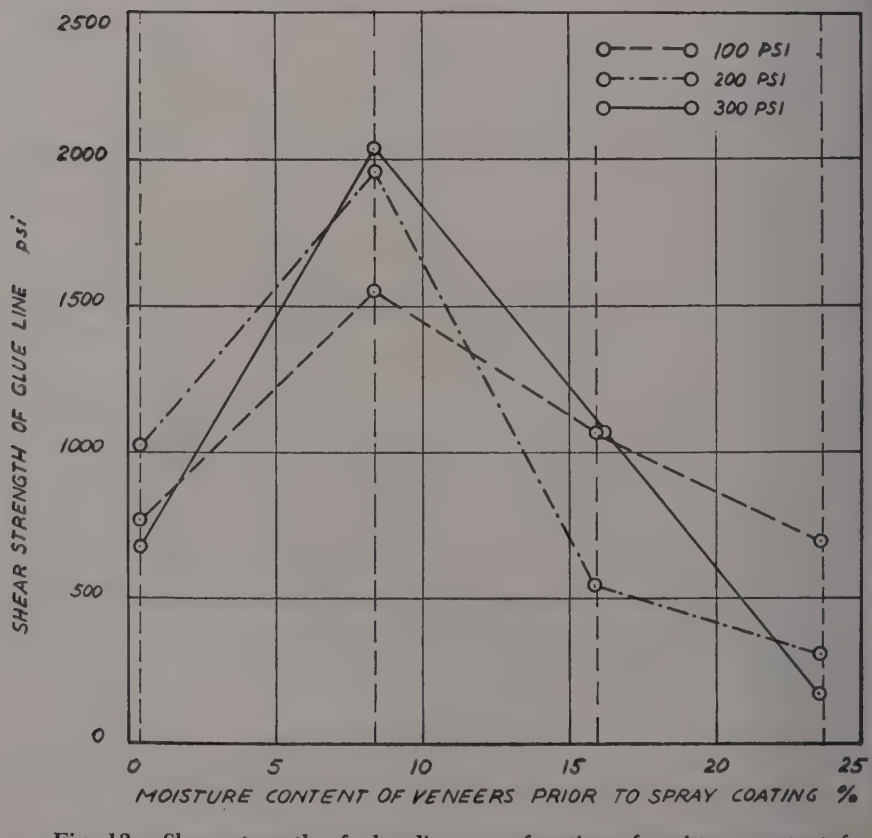

Fig. 13. Shear strength of glue line as a function of moisture content for different laminating pressures, disregarding effect of glue spread.
Conditions: Same as in Fig. 12.

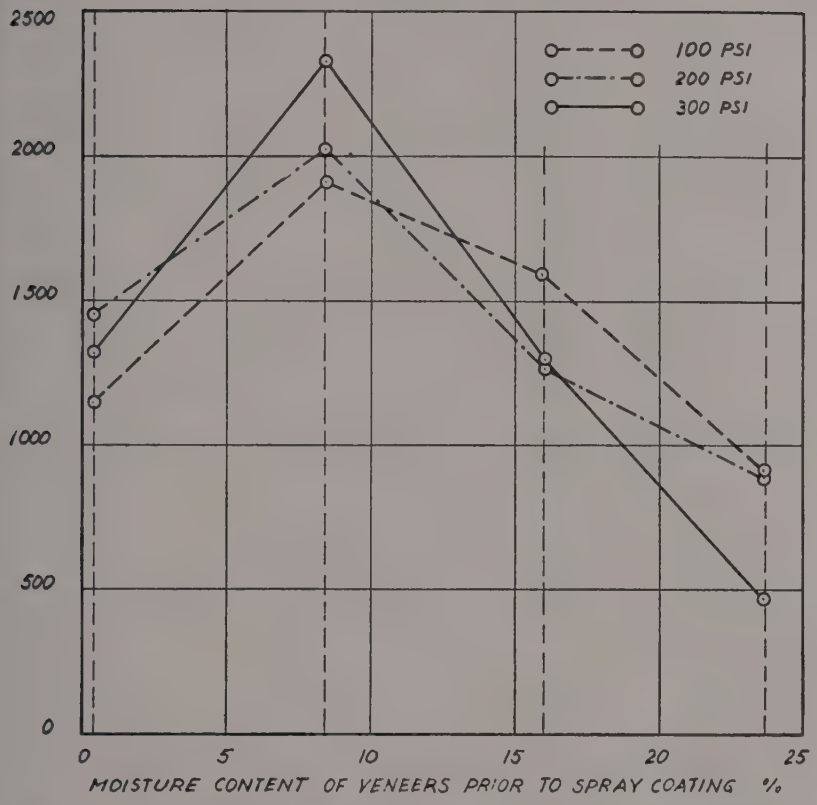

Fig. 14. Shear strength of glue line as a function of moisture content for different laminating pressures. Average glue spread: 1.51 g/ft² Conditions: Same as in Fig. 12.

b) Effect of laminating pressure on joint strength

0.4 percent M.C. series: The difference in the effect of the three pressures is not significant.

8.4 percent M.C. series: Higher pressures resulted in higher joint strength. The significance of this result is between the 20 percent and 5 percent level and not very conclusive.

16.0 percent M.C. series: 100 psi laminating pressure resulted in higher joint strength than 200 psi pressure (significance level 5 percent). Differences between 100 psi and 300 psi and between 200 and 300 psi pressures are not significant.

27.3 percent M.C. series: 100 psi laminating pressure gave

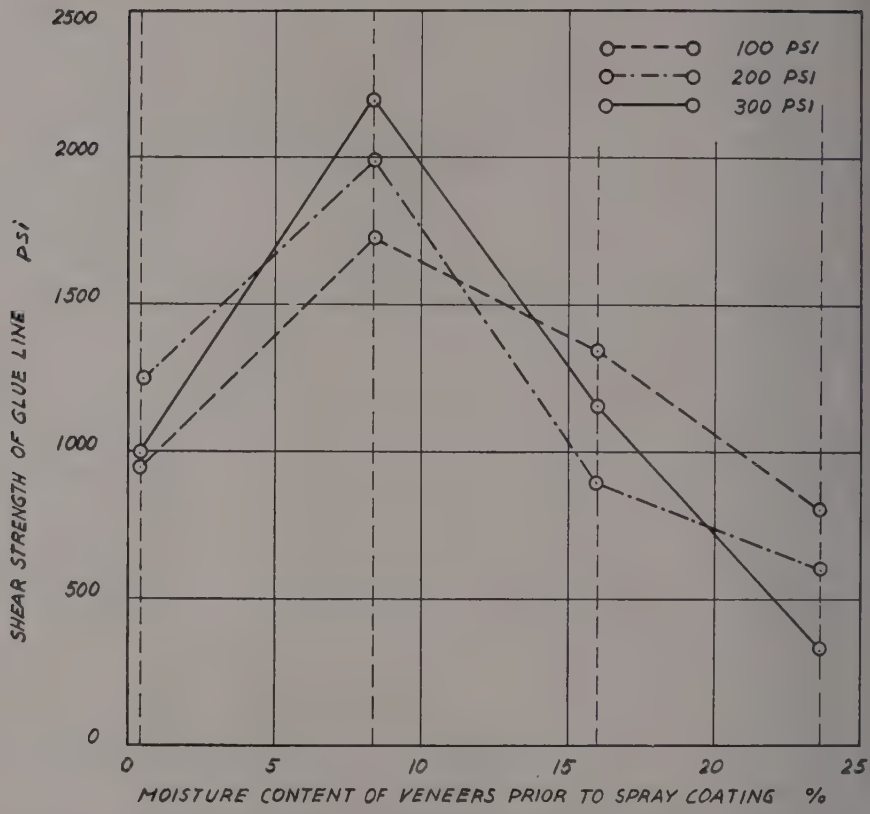

Fig. 15. Shear strength of glue line as a function of moisture content for different laminating pressures. Average glue spread: 0.61 g/ft²

higher joint strength than 300 psi pressure (5 percent significance level). Differences between 100 psi and 200 psi pressures and between 200 and 300 psi pressures are not significant.

c) Effect of glue spread on joint strength

0.4 percent M.C. series: Higher glue spread increased joint strength (1 percent significance level).

8.4 percent M.C. series: Effect of glue spread is not significant.

16.0 percent M.C. series: Higher glue spread increased joint strength (5 percent significance level).

23.7 percent M.C. series: Higher glue spread increased joint strength (5 percent significance level).

CONCLUSIONS

Low density wood (spec. gravity<0.5)

Glue spreads as low as 0.3 g ft^2 will, under favorable conditions, produce joint strength comparable to that of glue joints obtained with conventional glue spreads. The shear strength of the glue line proved to be higher than the shear strength of the wood and could not be determined.

A glue spread of 0.3 g/ft^2 is equivalent to a uniform film thickness of 85 x 10^{-6} inches if the specific gravity of the glue is taken to be 1.5. This is equal to 2 μ (2 x 10^{-3}mm). In relation to the structure of the surface of a low density wood, this film would appear as shown in Fig. 16. Under those conditions not even the cells representing the wood surface could be filled with adhesive. The actual area of contact under ideal conditions would depend upon the specific gravity of the wood or the percentage of solid wood substance. The per-

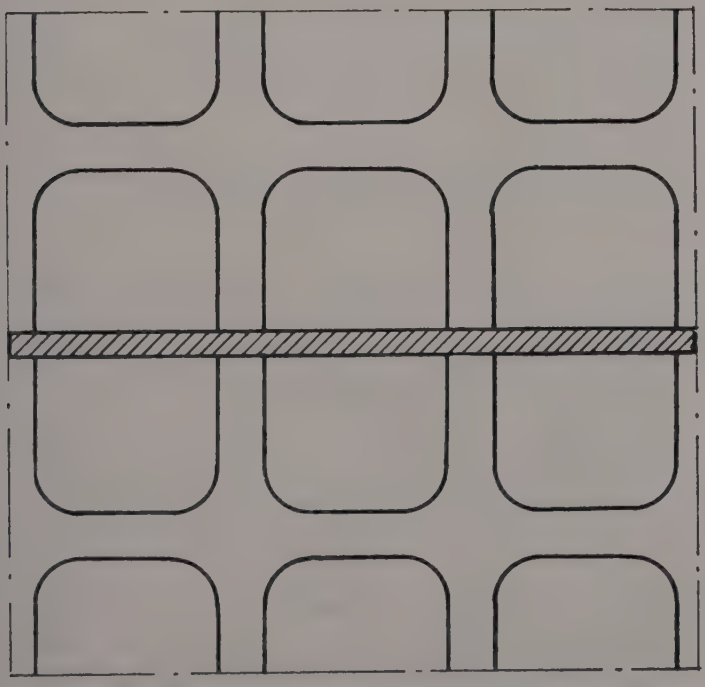

Fig. 16. Schematic drawing of a 2 μ thick glue line in relation to the structure of a low density wood.

centage of solid wood substance is a function of the specific gravity of the wood and can be expressed as follows:

$$m = \frac{1}{\gamma} r_o$$

where m = percentage of solid wood substance
γ = specific weight of cellwall substance (1.5 g/cm³)
r_o = specific gravity of wood at 0 percent M.C. (g/cm³)

Obviously $\underline{m}$ is proportional to the actual surface area of exposed cell walls expressed as the sum of x_1 or the sum of x_2 in Fig. 17. It follows that the relative surface areas of exposed cell walls are:

$$s_1 = \frac{\Sigma x_1}{\Sigma x_1 + \Sigma y_1} = m \quad ; \quad s_2 = \frac{\Sigma x_2}{\Sigma x_2 + \Sigma u_2} = m$$

The relative area of contact between cell walls is:

$$C = s_1 \cdot s_2 = m^2$$

Expressed as a function of the specific gravity of wood Fig. 18 will be obtained.

For a species of the specific gravity of 0.45:

$$m = \frac{1 \times 0.45}{1.50} = 0.3 \quad \text{and} \quad C = m^2 = 0.09$$

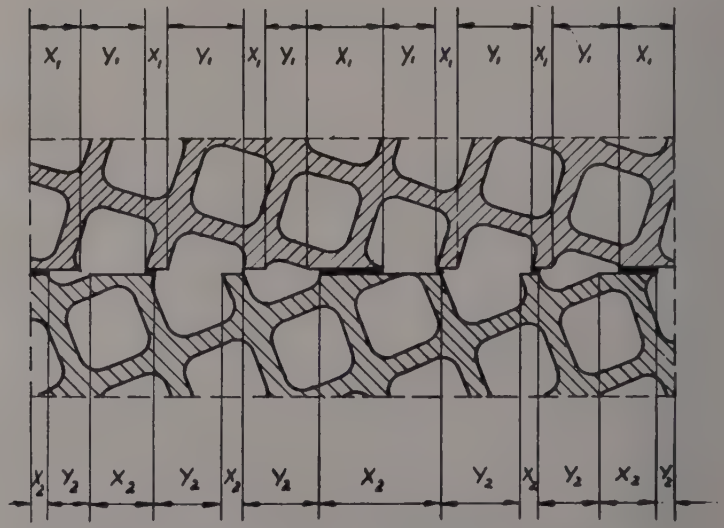

Fig. 17. Schematic drawing demonstrating surface area of sectioned cell walls and area of contact between cell walls.

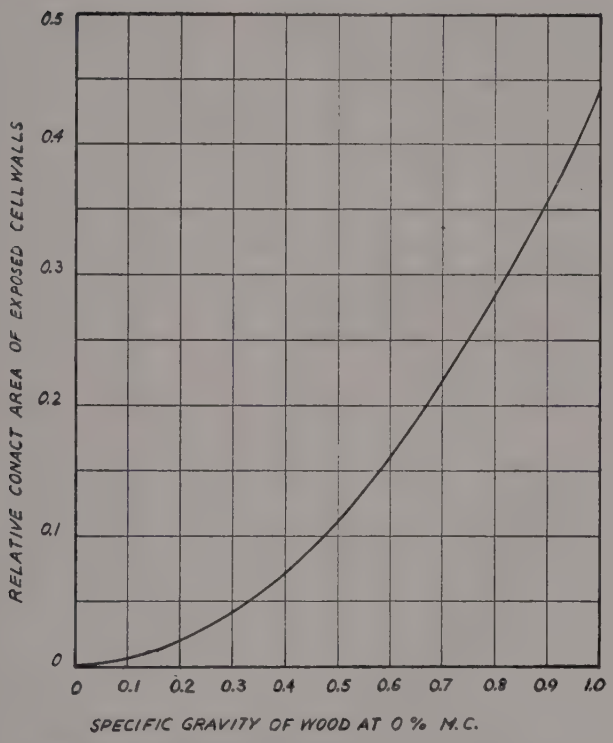

Fig. 18. Relative contact area of exposed cell walls as a function of specific gravity of wood at 0 percent M.C.

This means, that under ideal conditions the shear area of the glue line is about one third of the cross section area of the cell walls. The fact that the shear tests of those glue lines resulted in wood failure would indicate that the actual glue line shear stress must have been at least three times as high as the shear stresses in the cell walls. But this is unlikely.

Based on the results and the preceding discussion, the following explanation is offered:

> Thin flexible members can be laminated with minimum glue spread when the combined effect of heat, moisture content of the wood, and uniform pressure will cause the exposed surface layer of cells to be densified and thus form a continuous glue line.
>
> The ideal combination of those three factors will vary with

the specific gravity of the species in question, the dimensions of the laminas, and the curing characteristics of the adhesive. A variation of one of the factors might be balanced by corresponding changes of the other factors in a limited range. Excessive pressure combined with high moisture content seems to result in crushing and cell collapse.

Little is known about the compression strength of wood under extreme conditions of high temperature and high moisture content. A thorough study of this problem will be helpful for the selection of proper press cycles, especially for high density flake boards.

High density wood (specific gravity>0.5)

The results show that the shear strength of the glue line with minimum glue spread is lower than the shear strength of the wood and does not compare with results obtainable with conventional glue spreads.

It cannot be concluded, however, that the shear strength is a function of the glue spread. The pronounced effect of moisture content and laminating pressure on the joint strength, indicate that the proper gluing conditions might be rather critical. It might well be possible that higher pressures at low moisture content would result in the type of bond which was assumed to have taken place in the case of lower densities.

Application of results to the gluing problem in flake boards

It is important to consider a flakeboard as being a lamination of individual laminas of definite dimensions which have certain mechanical properties. In order to control the quality of such boards, an analytical rather than an experimental approach is desirable.

To make the glue bond as strong as the adherent might be considered the ultimate goal of any gluing project. This can be achieved with minimum glue spreads as far as lower wood densities are concerned.

Theoretically, the strength of softwood flake boards is therefore limited and cannot be increased substantially by merely raising the glue level.

It seems quite possible, however, to increase the strength of hardwood flake boards considerably by increasing the glue spread to

about 1.5 to 2.0 g/ft² which is equivalent to about 10 percent to 13 percent glue content on 0.01 inch thick flakes having a density of about 0.65.

The quality of glue-bonds obtainable with glue spreads equivalent to those used in particle board manufacture have been demonstrated in this study. In order to fully utilize the strength of those glue bonds, size, and shape of the flakes should be designed accordingly.

Theoretical treatment of the stress distribution in a flake board should result in optimum flake length to flake thickness ratios for various species and orientation conditions.

This problem is the subject of further study.

SUMMARY

Glue lines similar to those prevailing in the manufacture of flake boards were produced and tested.

In the case of low density woods, glue spreads as low as 0.3 g/ft² produced glue joints with a shear strength stronger than the wood. An analysis of the results led to the assumption that a continuous glue line is formed by densification of the exposed surface layers of cells under uniform pressure.

The strength of glue joints in higher density species did not exceed the strength of the wood, and an effect of glue spread on joint strength was apparent. The pronounced effect of moisture content and laminating pressure on the joint strength indicate that the proper gluing conditions are rather critical.

A RAPID DRYING OVEN FOR DETERMINING THE MOISTURE CONTENT OF CROP SAMPLES IN THE FIELD[1]

By G. W. ISAACS and D. E. WIANT[2]

NEW CROP HARVESTING and preservation practices are increasing the farmer's need for a moisture tester for use on the farm. The use of a mow hay drier may require him to recognize 35 percent moisture hay instead of hay of 20 percent moisture with which he is more accustomed. Farmers using batch-type and continuous-type grain driers need a moisture tester at hand for efficient management of their driers. Many farmers have learned that over-drying grain "just to be safe" can be costly as can underdrying and the resultant spoilage. No premium is paid for grain marketed at below the moisture content allowable for its quality grade.

General design requirements for a farm moisture tester are listed as follows:

1. Accuracy
2. Rapidity
3. Simplicity of Operation
4. Low Cost
5. Versatility

In general, the farm moisture tester is an instrument for quality control and not for direct use in market transactions. The accuracy required is in general based upon the moisture tolerance of the storage or processing operation to which the product is to be subjected. The storability of grain and field-cured hay can be determined with a moisture meter accurate to less than one moisture percentage point.

[1]Isaacs, G. W. (1954). The design of simplified equipment for the rapid determination of the moisture content of grain and forage crops. Thesis for the Ph.D. degree, Michigan State University Research performed under the Research and Marketing Act Contract No. A-1s-33696 between Michigan State University and the United States Department of Agriculture.

[2]The Authors—G. W. Isaacs and D. E. Wiant are, respectively, Associate Professor of Agricultural Engineering, Purdue University, and Professor of Agricultural Engineering, Michigan State University.

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A measurement having an accuracy of ± 3 or less moisture percentage points should indicate when hay has field dried enough to place on a mow hay drier. Less accuracy might suffice for indicating when to store forage for silage.

Since samples of field crops, particularly hay, frequently are non-uniform in moisture content, a farm moisture tester should be rapid enough to enable the farmer to take a large number of samples in a reasonable length of time.

Low cost is an important, but not always easily attainable, characteristic of a successful farm moisture tester. Any farmer who has had a serious crop loss due to spoilage in storage might well have afforded to pay several hundred dollars for a moisture tester; however, it is not likely that a moisture tester selling for over $100 will find very wide acceptance for some time.

A farm moisture tester should be applicable to the principal grain and forage crops in the ranges of moisture contents which are of interest in the various harvesting, curing, and storage procedures. A successful moisture meter should be able to determine the storage quality of grain recently dried as well as that recently harvested. It should be capable of testing forage crops for silage at 60 to 75 percent moisture as well as hay for unventilated storage at less than 25 percent moisture content.

The Tractor Exhaust Oven

The first use of heat from an engine exhaust to dry samples for moisture determination was reported by Dexter[3]. His oven, for which a patent was granted[4], consists of a cylinder which contains the sample through which the exhaust gases are passed.

The operating procedure outlined by Dexter includes selecting a representative sample, weighing it in the cylinder on a platform-type spring scale, attaching the oven to the exhaust pipe, and heating the sample until a constant weight is attained. The initial and final net weights are used to calculate the moisture content. The sample temperature is measured by a thermometer and manually controlled at about 284° F. by carefully adjusting the engine speed. To prevent burning during the heating process, the cylinder containing sample is turned end-for-end in the oven once per minute. Six minutes are

[3]Dexter, S. T. (1947) A Method for rapidly determining the moisture content of hay or grain. Mich. Agr. Expt. Sta. Quart. Bul. v30, n2; 158-166, 1947.

[4]Dexter, S. T., U. S. Patent No. 2,531,673, (Assigned to Mich. State Coll.)

required to dry a sample of mixed grass of 15.8 percent moisture. Ten minutes are required for a sample of 38 percent moisture.

Simplification of the procedure used with the exhaust oven method seemed possible if a means could be found to reduce the temperature of the gas passing through the sample, and to make the temperature less dependent upon the throttle setting. Fig. 1 shows a new type of exhaust oven developed during this contract project between Michigan State University and the U.S. Dept. of Agriculture[5]. An injector pump assembly (commonly called a "jet" pump) is located between the engine exhaust and the sample container. The engine exhaust gas is directed into the nozzle of the injector pump, causing it to induce a flow of ambient air which is mixed with the exhaust gas and passed through the sample container. Thereby the mixture of gases flowing through the sample is lower in temperature and flows at a higher rate than if the exhaust gas alone were passed through the sample. Both of these characteristics are desirable for obtaining rapid drying of the sample without burning. Also, reversing the sample is eliminated.

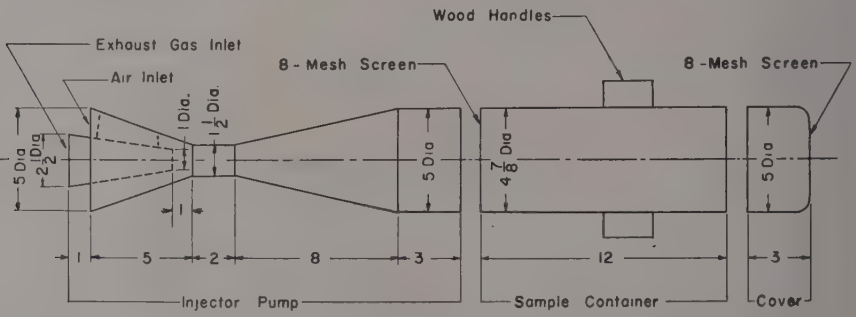

Fig. 1. Diagram of the injector-type tractor exhaust oven.

Fig. 2 shows the injector-type exhaust oven installed on a farm tractor.

A platform-type spring scale equivalent to a spring-type dietetic scale is sufficiently accurate for use in moisture testing forage crops if test weights are used for occasional calibration. Its retail cost is approximately nine dollars. In testing grain, where a moisture determination accuracy of one moisture percentage point or better is desired, a balance should be used which has a rated sensitivity of 0.1 gram. A suitable balance is available at a retail cost of $23.

[5]Isaacs, G. W., U. S. Patent No. 2,794,269.

Fig. 2. The injector-type exhaust oven in operation on a farm tractor.

A simple means of computing the moisture contents from any combination of original and final sample weights is needed. Such a device, in the form of a mechanical nomograph or alignment chart, was constructed of sheet steel. The nomograph as shown in Fig. 3 is set for a wet weight of 160 grams and a dry weight of 80 grams. It correctly indicates a moisture content of 50 percent wet basis.

Test Results

Results of one of the laboratory tests of the experimental exhaust oven are shown in Fig. 4, where temperatures and sample weights are plotted against time from the start of drying. The points at which the temperatures were taken are shown in the inserted injector diagram in the figure. The maximum temperature of the samples during this test was 270° F. A temperature difference (T_1-T_2) of approximately 350° F. was observed between the entering exhaust gas temperature T_1 and the temperature T_2 of the exhaust gas and air entering the sample. This temperature difference is a measure of the effectiveness of the injector in reducing the sample temperature below the exhaust temperature and increasing the rate of flow of gases through the sample.

Samples of hay weighing from 100 to 200 grams can be dried in from seven to ten minutes. Samples of corn require from 15 to 20 minutes to dry. The smaller grains dry in from 10 to 15 minutes.

Moisture samples dried in the exhaust oven tests were further tested by placing them in a laboratory air oven at 220° F. for a period of 48 hours for hay and 96 hours for grain. Further loss in weight was assumed to be equivalent to the moisture which the exhaust oven failed to remove, although some dry matter was probably lost in the laboratory oven. The residual moisture was expressed as a percentage of the original (wet) sample weight and calculated as follows:

$$\text{Percent Residual Moisture} = \frac{\text{Exhaust oven dry weight} - \text{Laboratory oven dry weight}}{\text{Original sample weight}}$$

Moisture data from tests of the exhaust oven on hay and grains are presented in Table 1 which summarizes these data and presents the arithmetic mean and the standard deviations of the moisture

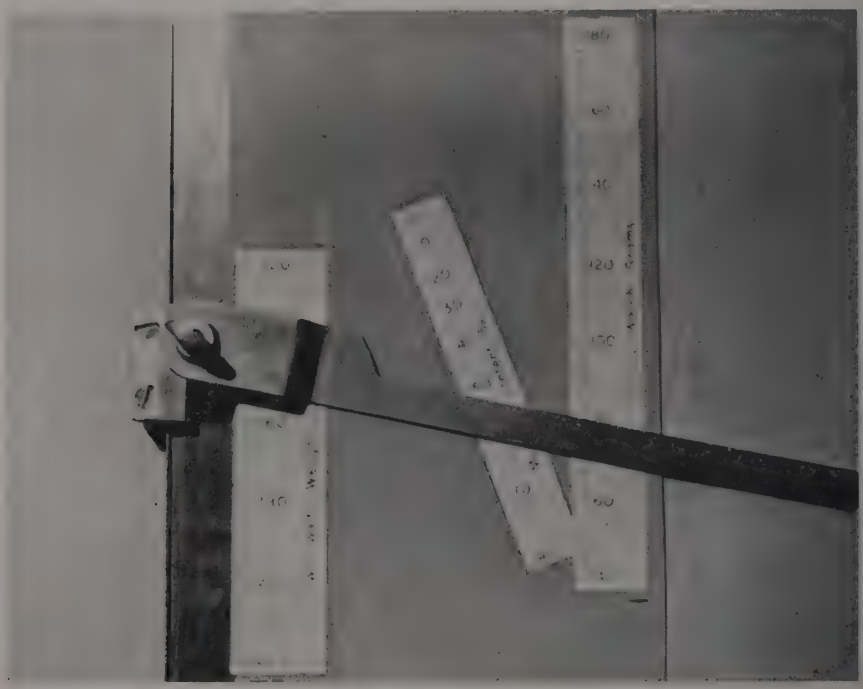

Fig. 3. A mechanical nomograph for computing moisture content from various combinations of wet and dry sample weights.

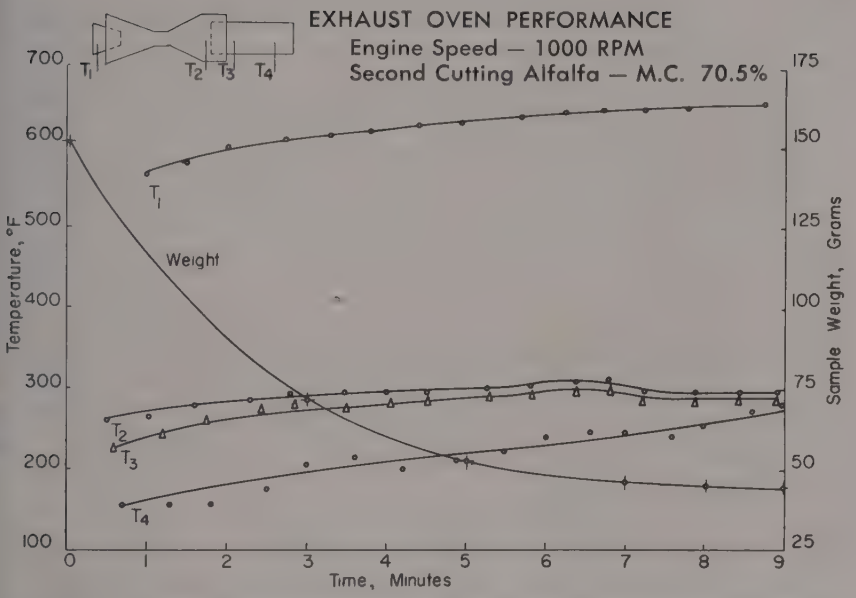

Fig. 4. Typical operating temperature and drying characteristics of the injector-type exhaust oven.

residuals. The residual moisture values for the large-kerneled grains such as corn and pea beans were the only ones found to be significant. Therefore, when the exhaust oven is used on these grains, the moisture determination should be corrected by adding the mean residual moisture value for the grain being tested.

TABLE 1—Summary of moisture residual data for hay and grain

Crop tested	Mean residual moisture content, percent	Standard deviation of the mean residual moisture content, percent
Alfalfa and alfalfa-brome hay	−1.36	1.04
Oats	−0.10	0.09
Corn	1.30	0.30
Corn(*a*)	2.34	0.71
Wheat	1.12	0.92
Pea Beans	0.96	0.05

(*a*) This series of samples was adjudged dry by the constant weight indications of a spring scale of 1.0 gram sensitivity. All other samples in the table were adjudged dry by a balance of 0.1 gram sensitivity when two readings constant within 0.5 gram were observed.

Two samples of alfalfa were heated at 212° F. for 24 hours in a vacuum oven after being dried in the exhaust oven and laboratory air oven. Less than 0.1 percent further weight loss occurred.

An attempt was made to reduce the residual moisture in corn samples by grinding or crushing the samples and heating them in a sample container made from fine screen. The method was unsuccesful because screens which were fine enough to stop the finely-divided parts of grain from blowing out were so fine that they seriously reduced the air flow.

A series of protein and sugar analyses of samples of alfalfa hay were made for the purpose of comparing the effects of the exhaust and laboratory ovens on these usually unstable dry-matter constituents. The protein and sugar content of the samples dried in the exhaust oven did not differ significantly from that of the samples dried in the laboratory oven.

Conclusions

The injector-type exhaust oven has the following features which make it desirable for determining the moisture content of grains and forages on the farm:

1. Simple and readily understandable operating procedure.
2. Relatively low cost.
3. Rapid enough to follow the drying progress of products in most farm processes such as the field or mow-curing of hay or the artificial bin-drying of grain.
4. Accuracy not affected by secondary factors such as ambient temperature, humidity, sample species and variety, or non-uniform moisture distribution in the sample.
5. The operator need not watch the sample while it is drying. Leaving the sample in the oven longer than necessary apparently does not affect the results.
6. Applicability over the full range of moisture content measured in grain and forage crops.

The following are limiting features of this method of moisture determination:

1. The drying rate is not rapid enough to encourage testing many samples; therefore, sampling error may be great in testing non-uniform

products. The accuracy is dependent upon whether or not the samples tested represent the parent population.

2. The accuracy in testing a given sample is chiefly dependent upon the accuracy of the two weighing operations required.

3. Significant quantities of residual moisture remained in corn and pea bean samples after drying in the exhaust oven. Correction must be made for residual moisture content when testing samples of these grains.

AN AVERAGING-TYPE METER FOR MEASURING THE MOISTURE CONTENT OF HAY IN THE WINDROW[1]

By G. W. ISAACS and D. E. WIANT[2]

ELECTRICAL MOISTURE METERS potentially satisfy many of the design requirements for a moisture meter for use by farmers on hay in the field. The apparatus can be made to provide direct and instant reading; it is highly portable and readily applicable to other crops by calibration. The authors have tested two commercially available meters designed for hay and grain on alfalfa and alfalfa-brome hay.

The readings obtained with the two meters tested were compared with moisture contents determined by using a laboratory air oven procedure. A summary of the data is presented in Table 1 as a statistical comparison of the meter readings and the oven-determined moisture contents. Equations of the regression lines describing the data are presented.

In these equations, Y represents the meter reading and X represents the oven-determined moisture content. The standard error of estimate of the meter readings, with respect to the oven-determined moisture contents, is presented. The standard error of estimate is a statistical indication of the accuracy of the meters tested. For example, a standard error of 3.0 moisture percentage points indicates that approximately 68 per cent of the determinations made with the meter will be correct within $\pm$ 3.0 moisture percentage points of values read from a calibration curve described by the regression line equation.

In order to evaluate the variability of moisture content in the windrow, the oven-determined moisture contents of pairs of samples taken simultaneously about one foot apart in the windrow were compared. In the analysis, each member of each pair of samples was

[1]Isaacs, G. W. (1954). The design of simplified equipment for the rapid determination of the moisture content of grain and forage crops. Thesis for the Ph.D. Degree, Michigan State University. Research performed under the Research and Marketing Act Contract No. A-1s-33696 between Michigan State University and the United States Department of Agriculture.

[2]The Authors—G. W. Isaacs and D. E. Wiant are, respectively, Associate Professor of Agricultural Engineering, Purdue University, and Professor of Agricultural Engineering, Michigan State University.

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TABLE 1—Summary of data from commercial moisture meters tested on hay

Meter	Hay	Moisture range in percent	Equation of regression line	Standard error
A	Alfalfa—brome....	22-47	y=0.657x+ 1.85	2.1
A	Alfalfa—brome....	22-47	y=0.628x+ 3.0	3.1(*a*)
A	Alfalfa.....	17-45	y=0.476 + 8.65	2.8
A	Alfalfa.....	17-45	y=0.396x−11.2	3.9(*a*)
B	Alfalfa—brome....	18-40	y=1.17x − 8.6	4.1
B	Alfalfa—brome....	40-65	y=0.601 +13.6	5.0
B	Alfalfa.....	11-38	y=0.882x+ 1.8	3.3
B	Alfalfa.....	11-38	y=0.968x+ 0.0	5.1(*a*)

(*a*) These data were analyzed as individual meter readings against the oven-determined content. All other entries were analyzed as the average of five meter readings vs. the oven-determined moisture content.

placed in one of two groups, Group A or Group B. The standard error of estimate of the moisture content of samples in Group A compared to the moisture content of samples in Group B was found to be 3.4 moisture percentage points for 26 pairs of samples of alfalfa hay. For a similar test on alfalfa-brome hay, the standard error of estimate was 4.5 moisture percentage points.

The Averaging Resistance-Type Moisture Meter

The non-uniformity of the moisture content of hay in the windrow is qualitatively apparent from visual and tactual inspection. The conclusions drawn from the tests of the commercial meters were that an individual reading taken with these meters was not a good indication of the average moisture content of a windrow of hay. However, if farmers are willing to take a great number of individual readings (at least 25) and determine an average reading, they may obtain a reliable indication of the moisture contents of fields of hay. It is also probable that most farmers would not follow this tedious procedure for long, and would assume the validity of individual readings. As a solution to this problem, a device was developed for automatically averaging a large number of moisture content readings based on electrical resistance measurement.

A schematic diagram of an experimental averaging or scanning device for use with a resistance-type moisture meter is shown in Fig. 1. A continuously rotating electrical tap switch, S_1, can be made to connect any one of the n electrode sets (E_1, E_2, E_3—E_n) to the resistance measuring circuit. By this arrangement, one can conven-

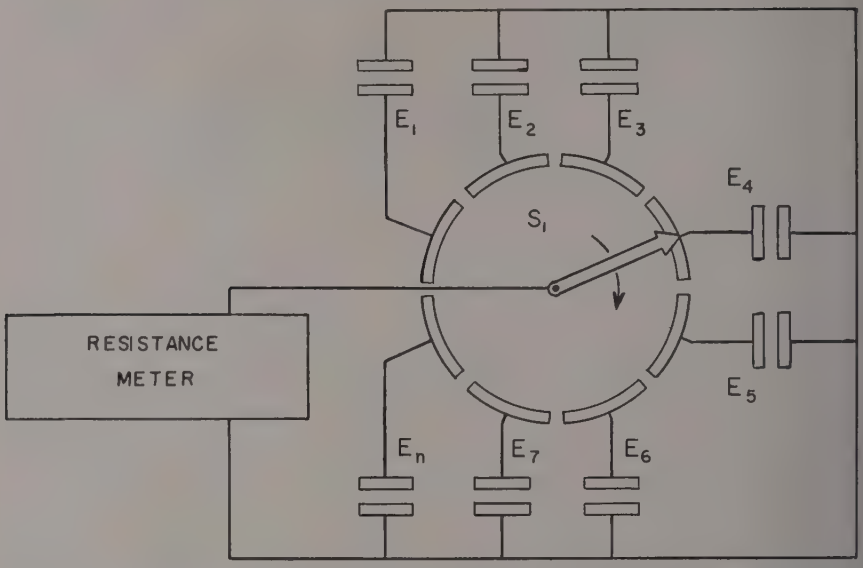

Fig. 1. Schematic diagram of an averaging or scanning device for use with a resistance-type moisture meter.

iently take separate readings of moisture content, M, based on resistance, R, of several samples, and average them to determine the arithmetic mean moisture content of all the samples.

If the switch arm of the rotary switch is rotated at a constant speed, the pointer of the resistance meter will attempt to follow the changes in the measured resistance as the switch arm contacts different samples, but because of its inertia and electro-dynamic damping, it cannot do so. If the switch arm is rotated rapidly enough and the damping of the meter movement is great enough, the meter will approach a steady reading of resistance equivalent to the mean conductance or the mean of the reciprocals of the sample resistance.

In order for a measurement of mean conductance to indicate average moisture content, the assumption must be made that moisture content is inversely proportional to resistance. This assumes that the relation between resistance and moisture content is hyperbolic instead of exponential, as it is usually considered to be. However, the error in determining the average moisture content is not great if there is not unreasonable variation in the moisture content of the individual samples.

An averaging resistance-type moisture meter for windrowed hay was designed and constructed, (Fig. 2). Twenty-one sets of pin-type electrodes were positioned radially around the periphery of a wheel twenty inches in diameter. A 21-point rotary switch was placed in the center of the sheet. The body of the switch was fixed to the wheel and the rotor was fixed to the frame within which the wheel rotates. As the wheel is rolled down the windrow, a resistance meter measures the mean conductance of the samples contacted and in turn indicates the approximate average moisture content.

Fig. 2. The averaging resistance-type moisture meter for windrowed hay.

Fig. 3 presents the data taken with this device on alfalfa and alfalfa-brome hays. The logarithm of resistance readings taken as the wheel passed specific points in the windrow are plotted against oven-determined moisture contents. Since the error in obtaining exactly the same hay for the oven sample that the wheel contacted is undoubtedly great, these data probably do not represent a very fair test of the meter.

Fig. 4 is a plot of the average moisture content of three simultaneously drawn oven samples against the resistance reading. The standard

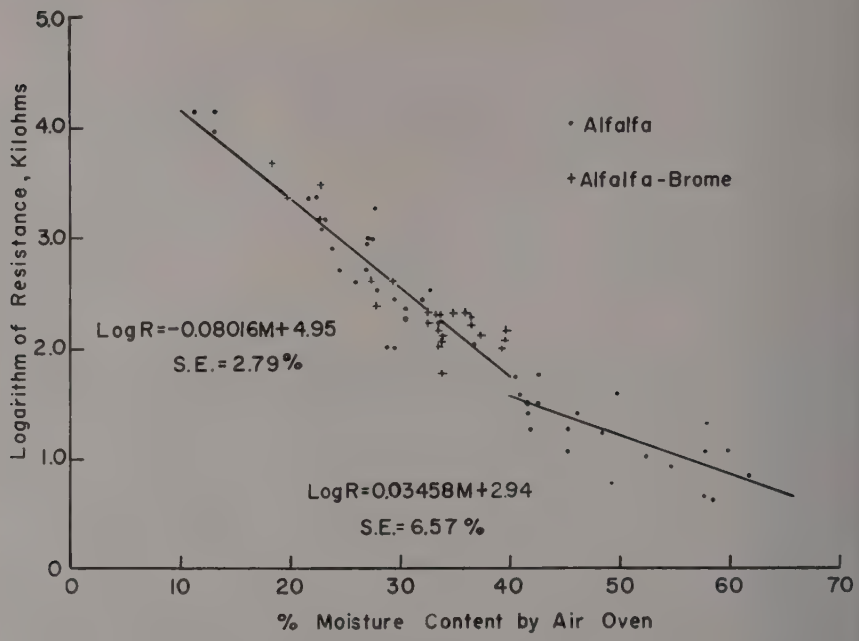

Fig. 3. Field data from tests of the averaging resistance-type moisture meter.

error of estimate for this data was 2.11 for moisture contents above 40 per cent. In comparison, the standard error of estimate for the data of Fig. 3 was 2.79 moisture percentage points below 40 per cent moisture and 6.57 above 40 per cent moisture.

Possible applications of the averaging device to products other than forage in the windrow have been recognized. The device could very likely find application in process industries associated with paper making, cotton milling, and tobacco products manufacture.

SUMMARY

The automatic averaging or scanning principle has been shown to reduce the variability of moisture content measurements made as a function of electrical resistance of hay in the windrow.

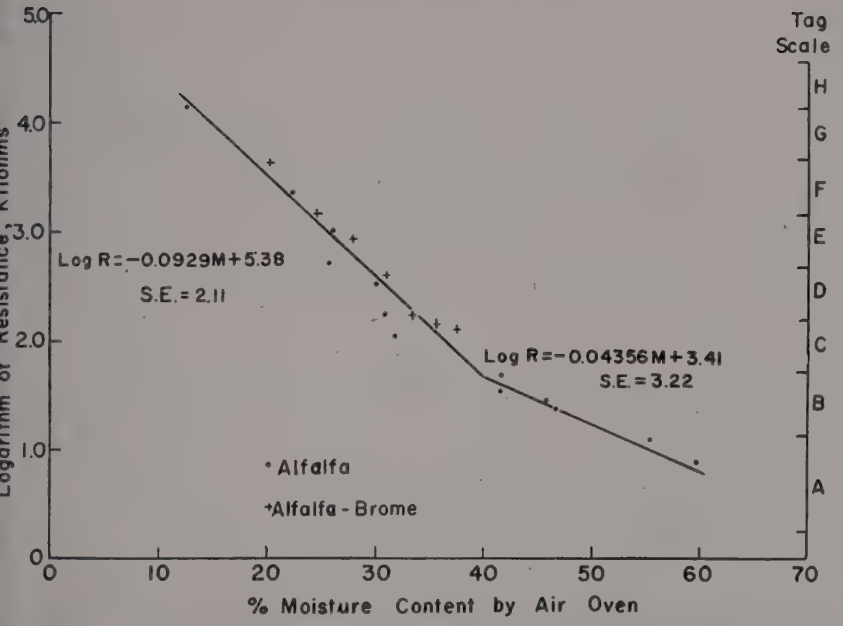

Fig. 4. Field data from tests of the averaging resistance-type moisture meter. Logarithm of resistance vs. the average moisture content of three oven samples taken simultaneously.

EVALUATION OF INSECTICIDES FOR CONTROL OF THE CHLORINATED HYDROCARBON RESISTANT ONION MAGGOT

By GORDON GUYER and ARTHUR WELLS

DEPARTMENT OF ENTOMOLOGY

THE ONION MAGGOT, *Hylemya antiqua* (Meig.), was a serious problem with Michigan growers during 1957 and 1958. This was in direct contrast to the excellent control that has been obtained with the use of chlorinated hydrocarbon insecticides since 1951.

During the harvest of 1956, an extensive population of onion maggot pupae was observed in a field in the Stockbridge area. This field had been continuously in onions for several years and had received numerous foliar applications of chlorinated hydrocarbon materials in addition to furrow treatments of dieldrin. Laboratory studies during the winter of 1956-1957 indicated conclusively that the flies emerging from pupae collected from this field were resistant to chlorinated hydrocarbon materials.[1]

By the end of the 1957 season, the problem of resistance had spread from the restricted area at Stockbridge to all onion growing areas of the state. In the Grant and Gun Marsh areas, serious field populations did not develop until the spring of 1958. During 1958, onions grown in home gardens throughout the state suffered severe maggot damage.

Preliminary laboratory data indicated that several organophosphorus materials were effective for control of chlorinated hydrocarbon resistant onion maggots. Since Kästner[2] reported that the behavior of the onion maggot in the laboratory was completely different from activity in the field it was concluded that a detailed field evaluation

[1]Drew, William and G. Guyer (1958). Test methods for evaluating insecticides against the onion maggot. Proc. N. Central Br. Ent. Soc. Amer. XIII: 43-44.

[2]Kästner, Alfred (1929). Untersuchungen zur Lebensweise und Bekämpfung der Zwiebelfliege (*Hylemya antiqua* Meigen). Zeitschrift für Pflanzenkrankheiten (Pflanzenpathologie) und Pflanzenschutz 39: 49-97.

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of control procedures should be initiated. In 1958, a field program was established to evaluate insecticides for control of the resistant maggots.

METHODS

Plots were located in Ingham and Jackson Counties in the Stockbridge area; at Grant in Newago County and at the Muck Experimental Farm at Bath, Clinton County. The Stockbridge and Grant plots were a distance of 140 miles apart. At each location, 40 treatments were arranged in a randomized block design. At the Muck Experimental Farm, six additional treatments were included in the layout. Each treatment consisted of a single 10-foot row replicated five times. The row spacing was 16.5 inches.

The treatments of dry materials were made at the time of seeding with a V-belt seeder. The emulsifiable and wettable powder formulations were applied in water at the rate of 100 gallons per acre. The treatment was made to an open furrow with a calibrated squeeze bottle using a directional orifice, simulating commercial application. The furrow was closed immediately after treatment. Seed of Downing's yellow globe variety was planted at the rate of 4 pounds per acre. The Muck Experimental Farm plot was seeded on April 15, the Ingham County plot April 17, Jackson County April 25 and the Newago County plot on May 5. The pH of the soil at the four areas was 5.7, 5.6, 5.7 and 5.4, respectively. All plots were located on muck soil. A complete fertilizer was banded below the seed at rates comparable with those in the plantings where the experimental plots were located.

The plots were not treated with foliar applications of insecticides. The Muck Experimental Farm plots were harvested September 9, the Ingham County plots September 3 and Newago plots September 17. The materials evaluated, formulations, and rates of application are presented in Table 1.

Onions from the 2-pound-per-acre parathion and Diazinon treatments as well as the control at the Newago County and Muck Experimental Farm plots were evaluated for quality by members of the Department of Foods and Nutrition. The onions were peeled, sliced in small wedges, wrapped in Saran wrap, coded and submitted to panels of untrained judges for evaluation of general appearance, color, odor, flavor and texture. Thirty-two separate judgments were obtained for each characteristic for each treatment and location.

TABLE 1—Effect of insecticide treatments on plant stands in 1958 onion maggot plots

Material	Formulation	Pounds per acre(*a*)	Onions per row foot						
			Jackson Co.	Ingham County		Newaygo County		Muck Expt. farm	
			60 days(*b*)	68 days	141 days	73 days	137 days	49 days	149 days
Dieldrin	2% granulated	1	0.6	0.1	0.2	3.9	3.3	0	0
Dieldrin	2% granulated	3	0.6	0	0	5.2	4.0	0.4	0
Dieldrin+Arasan	2% granulated+A-75	1+2	0	0	0	3.8	2.9	0.4	0.2
Dieldrin+ Sesoxane	15%emulsion+ Sesoxane 1%	1+1 pt.	...	...	...	...	...	0.4	0
Dieldrin	15%emulsion	1	...	...	...	...	...	0	0
Aldrin	2% granulated	1	0.4	0	0	3.8	3.4	0.2	0
Endrin	1% granulated	1	2.2	0	0	5.4	5.2	2.2	0.3
Endrin	1% granulated	2	5.8	0.1	0.2	7.1	6.6	3.6	0.8
Heptachlor	2.5% granulated	1	0.4	0	0	2.9	1.3	0.1	0
Heptachlor	2.5% granulated	3	1.0	0	0	3.1	1.8	0.3	0.2
Chlordane	5% granulated	2	0.6	0	0	2.2	1.4	0	0
DDT	5% granulated	2	2.8	0.1	0	6.4	4.4	3.2	0.5
Thiodan	5% granulated	2	0.4	0	0	5.1	4.4	0.2	0
Sevin	2% dust	2	0.6	0	0	2.8	2.0	0.7	0
Parathion	5% granulated	½	2.8	0	0	11.1	8.5	18.1	10.7
Parathion	5% granulated	1	7.9	0	0	8.6	6.5	16.2	12.0
Parathion	5% granulated	2	12.1	0	0	9.5	8.4	13.8	11.6
Parathion	25% emulsion	2	1.6	0	0.2	5.0	2.8	9.2	4.6
Malathion	10% granulated	2	0.5	0	0	5.2	4.1	1.0	0.2
Ethion	25% wettable powder	½	0.8	0	0	0.8	0.2	6.2	1.8
Ethion	25% wettable powder	2	2.6	0	0	1.7	1.2	10.5	5.5
Trithion	5% granulated	½	3.4	0.1	0	7.1	5.6	4.4	1.1
Trithion	5% granulated	2	10.9	2.5	1.2	7.1	6.3	7.8	4.5
Guthion	5% granulated	½	2.5	0	0	6.1	4.7	2.0	0.2
Guthion	5% granulated	2	13.5	0.7	0.6	6.4	6.6	13.8	5.5

TABLE 1—Concluded

Material	Formulation	Pounds per acre(*a*)	Onions per row foot						
			Jackson Co.	Ingham County		Newaygo County		Muck Expt. farm	
			60 days(*b*)	68 days	141 days	73 days	137 days	49 days	149 days
Diazinon	3% dust	½	14.0	6.0	4.2	8.6	6.6	16.9	12.2
Diazinon	3% dust	2	19.8	7.8	6.8	8.9	6.2	16.2	15.7
Korlan	5% granulated	½	.5	0	0	1.7	1.6	3.8	0.5
Korlan	5% granulated	2	3.6	0.3	0	6.2	5.8	3.7	1.6
Thimet	2% granulated	1	13.0	6.9	5.2	9.8	8.0	15.8	12.7
Di-syston	5% granulated	1	5.6	0.1	0	7.2	5.8	8.3	4.2
Amer. Cyan. 12880	2% granulated	1	14.8	5.5	3.6	10.6	8.2	21.1	9.9
Amer. Cyan. 18706	2% granulated	1	7.6	0	0	4.0	3.2	3.5	0.6
Dicapthon	25% emulsion	1	0.4	0	0	0.8	0.8	1.8	0.5
Dylox	5% granulated	2	3.8	0.3	0	2.9	2.8	1.7	0.2
EPN-300	25% wettable powder	1	...	...	...	...	...	9.2	6.2
Kepone	10% granulated	1	0.8	0	0	4.8	3.2	0.5	0
Phosphamidon	89.5% emulsion	1 pt.	...	...	...	...	...	3.6	0.5
Tetram	90% wettable powder	1	...	...	...	...	...	2.8	1.5
Co-Ral	25% wettable powder	½	...	...	...	...	...	6.2	2.4
Co-Ral	25% wettable powder	2	2.6	0.1	0	4.3	3.2	11.6	6.8
Vapam	35% emulsion	2 qt.	0.1	0	0	0.5	0.4	3.1	1.3
Nemagon	25% granulated	2	0.9	0	0	1.4	1.3	0	0
Amer. Cyan. 18133	2% granulated	2	11.5	9.0	8.6	6.3	6.6	21.3	15.8
VC-13	95% emulsion	1 qt.	6.3	0.1	0	7.0	6.1	15.7	11.0
Control			0	0	0	2.2	1.8	3.6	1.0
Maximum common difference between averages (5%)			4.7	2.7	2.1	4.4	3.3	5.0	3.7
Maximum common difference between averages (1%)			5.9	3.4	2.7	5.6	4.2	6.3	4.7

(*a*) All rates are in pounds of actual insecticide unless otherwise designated.
(*b*) Days after seeding.

CHEMICAL CONTROL

Early stand counts were made following the damage by first generation larvae and before the initiation of second generation feeding (Table 1). Seedlings in the chlorinated hydrocarbon treatments were seriously damaged by the first generation larvae. Slight control was noted in the DDT and endrin plots. Dieldrin applied at four times the normal recommendation failed to provide control. The addition of Sesoxane did not increase the effectiveness of dieldrin.

There was great variation in control of first generation larvae treated with the organophosphorus materials. Generally, the heavier rates of Trithion, Guthion, Diazinon, Thimet, American Cyanamid 12880 and American Cyanamid 18133 provided excellent control during the entire season. The ½- and 2-pound rates of parathion generally gave control of first generation larvae but declined rapidly in effectiveness 6 to 8 weeks after seeding (Fig. 1).

Onions treated with the 2-pound rate of organophosphorus insecticides generally showed evidence of phytotoxicity. This was evident in yellowing of the leaves during early growth but was not observed at harvest. There was no evidence of a reduction in stand.

Fig. 1. The Muck Experimental Farm plots on July 29, 1958. The row on left was treated with ½ pound of parathion per acre (1958 commercial recommendation) and row on right with 3 pounds of heptachlor per acre.

Fig. 2. General view of the Ingham County plots on July 30, 1958. Middle row, foreground treated with 2 pounds of Diazinon and left row, foreground with 2 pounds of American Cyanamid 18133 per acre. All marked rows without onions were destroyed by onion maggot.

There was considerable variation in the magnitude of the maggot population at the four locations. The population in the Ingham County plots was the heaviest resulting in as many as 80 eggs per foot of row during the first generation activity. Maggots were numerous in the other locations indicative of normal field populations. Larvae were active in the plots throughout the season resulting in a progressive reduction in stand as the season advanced.

When the yields at the three locations were considered, the most effective treatments were Diazinon, Thimet, American Cyanamid 12880 and American Cyanamid 18133 (Table 2). During the entire investigation no larvae were observed in any of the American Cyanamid 18133 plots (Fig. 2). Other materials which produced yields significantly greater than the control were parathion, Ethion, Trithion, Guthion, Di-syston, EPN-300, Co-Ral, and VC-13.

Yields from plots receiving granulated parathion were approximately double of those where the liquid formulation was applied. It was generally concluded that the insecticides applied in a liquid formulation were much less effective than where dry applications

TABLE 2—Effect of insecticide treatments on yields from 1958 onion maggot plots

Material	Formulation	Pounds per acre(*a*)	50-pound bags per acre at harvest		
			Ingham County	Newaygo County	Muck Expt. farm
Dieldrin	2% granulated	1	3	480	0
Dieldrin	2% granulated	3	0	608	0
Dieldrin+Arasan	2% granulated+A-75	1+2	0	386	39
Dieldrin+Sesoxane	15% emulsion+ Sesoxane 1%	1+1 pt.	—	—	0
Dieldrin	15% emulsion	1	—	—	0
Aldrin	2% granulated	1	0	386	0
Endrin	1% granulated	1	0	679	65
Endrin	1% granulated	2	26	842	130
Heptachlor	2.5% granulated	1	0	293	0
Heptachlor	2.5% granulated	3	0	211	13
Chlordane	5% granulated	2	0	328	0
DDT	5% granulated	2	0	597	78
Thiodan	5% granulated	2	0	562	0
Sevin	2% dust	2	0	328	13
Parathion	5% granulated	½	0	889	1157
Parathion	5% granulated	1	0	765	1144
Parathion	5% granulated	2	0	1229	1144
Parathion	25% emulsion	2	14	620	676
Malathion	10% granulated	2	0	573	52
Ethion	25% wettable powder.	½	0	176	325
Ethion	25% wettable powder.	2	0	257	806
Trithion	5% granulated	½	0	831	156
Trithion	5% granulated	2	165	737	767
Guthion	5% granulated	½	0	632	52
Guthion	5% granulated	2	91	983	728
Diazinon	3% dust	½	600	842	1287
Diazinon	3% dust	2	898	948	1677
Korlan	5% granulated	½	0	199	104
Korlan	5% granulated	2	0	620	273
Thimet	2% granulated	1	765	1182	1327
Di-syston	5% granulated	1	0	749	598
Amer. Cyan. 12880	2% granulated	1	558	1252	910
Amer. Cyan. 18706	2% granulated	1	0	515	104
Dicapthon	25% emulsion	1	0	222	52
Dylox	5% granulated	2	0	456	39
EPN-300	25% wettable powder	1	—	—	702
Kepone	10% granulated	1	0	515	0
Phosphamidon	89.5% emulsion	1 pt.	—	—	104
Tetram	90% wettable powder.	1	—	—	247
Co-Ral	25% wettable powder.	½	—	—	429
Co-Ral	25% wettable powder.	2	0	503	988
Vapam	35% emulsion	2 qt.	0	105	208
Nemagon	25% granulated	2	0	222	0

(*a*) All rates are in pounds of actual insecticide unless otherwise designated.

TABLE 2—Concluded

Material	Formulation	Pounds per acre(*a*)	50-pound bags per acre at harvest		
			Ingham County	Newaygo County	Muck Expt. farm
Amer. Cyan. 18133..	2% granulated.....	2	1145	1065	1339
VC-13.....	95% emulsion.....	1 qt.	0	1088	1066
Control.....	.....	.....	0	246	182
Maximum common difference between averages (5%)..			245	451	330
Maximum common difference between averages (1%)..			312	576	420

were made. Consequently, it was postulated that dry formulations of Ethion and Co-Ral might produce satisfactory control of the onion maggot. Past results with commercial growers indicated that smaller granules are more effective than larger particles. This may explain why Diazinon as a 325 mesh formulation was consistently more effective than closely related 30-60 mesh organophosphorus materials.

ONION QUALITY

The data in Table 3 indicate that in the analysis of onion quality all "F" values were insignificant except in the case of the effect of treatment on texture, which was significant at the 5 percent level of

TABLE 3—Summary of analyses of variance for quality of mature onions from the parathion and Diazinon plots at the muck experimental farm and Newaygo County

	D.F.	"F" values				
		Flavor	General appearance	Odor	Color	Texture
Treatments.....	2	0.407	0.297	0.255	0.077	3.062*
Soils.....	1	0.010	0.265	0.179	0.003	0.070
Treatment x soil..	2	1.701	1.090	0.736	2.997	0.476
Error.....	186					
Total.....	191					

*Significant at 5 per cent level of probability.

probability. It was generally concluded that the difference in textur was the result of variations in growth pattern due to thinning in th control as compared with the parathion and Diazinon treatments

BIOLOGY

The onion maggot produced 3 generations during 1958. There wa considerable overlapping of generations as the season progressed By mid-July, all stages of the insect were observed in infested fields In general, first generation flies were active during late April an early May; second generation flies during late June; and third genera tion active during late August.

Observations made during 1957 and 1958 indicated that the re sistant maggot population may have developed variations in wha was considered normal biological activity of this insect. The resistan population appeared to continue active egg laying and larval develop ment during extremely hot dry weather of mid-summer. The adult and larvae were active in fields as late as November. Eggs deposite by the late fall generation were often placed directly below the larg mature onions. It was impossible to ascertain whether this activit was the result of increased population pressure or actually a chang in behavior.

SUMMARY

In 1958 a study was established in three onion growing areas o Michigan to evaluate insecticides for control of chlorinated hydro carbon resistant onion maggots. The results indicate that:

1. Onion maggot populations resistant to chlorinated hydrocarbo insecticides were present in all major onion growing areas of Michiga by the fall of 1957.

2. There was considerable variation in the magnitude of maggo populations in the three areas studied.

3. The most effective treatments were Diazinon, Thimet, Amer can Cyanamid 18133 and American Cyanamid 12880. Other materia which produced yields significantly greater than the control wer parathion, Ethion, Trithion, Guthion, Di-syston, EPN-300, Co-Ra and VC-13.

4. Treatments applied as granulated or dust formulations were more effective than liquid treatments at comparable rates.

5. There was no indication of off-flavor or reduction in quality of onions treated with parathion or Diazinon.

ACKNOWLEDGMENT

Special appreciation is extended to Dr. Evelyn Jones and her assistants for the excellent evaluation of quality of treated onions. Sincere thanks are made to Lawrence Shepherd of the Soil Science Department for providing facilities and supervision of the Muck Experimental Farm plots. Acknowledgment is extended to the commercial onion growers of Michigan for their constant encouragement and assistance during the study and especially to the Baldwin, Basore, Brink and Dixon farms for providing available plot areas.

EFFECT OF GIBBERELLIN ON THE YIELD AND MATURITY OF PROCESSING PEAS

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Peas are among the most responsive of all plants when treated with gibberellin. Bukovac and Wittwer (1956) found that dwarf American varieties behaved as tall varieties when the vegetative tips were treated with this chemical. They also noted seed treatments of gibberellin promoted more rapid and uniform germination and emergence of seedlings (Wittwer and Bukovac, 1957). Bonde and Moore (1958) and Barber, et al., (1958) reported that gibberellin delays flowering of peas physiologically because they flower at a later node and may induce abortion of the early flowers.

Preliminary field observations of gibberellin treated peas suggested that pod and seed maturity, as well as yield, were influenced. A specific objective of this study was to determine if gibberellin could be used to delay maturity of peas grown for processing, as measured by tenderometer readings, without reducing yield. Gibberellin might then be employed to alleviate seasonal concentrations of maturity resulting in more efficient use of harvesting and processing equipment and a higher quality canned or frozen product.

SEED AND EARLY POST-EMERGENCE TREATMENTS

Seeds of the Thomas Laxton and Perfection varieties of peas were treated with a slurry of 1000 p.p.m. mixture of gibberellin in "Delsan A-D"[2], or Delsan A-D only, and planted April 10 at East Lansing. Seed of gibberellin treated and non-treated seed of Thomas Laxton were also planted near Fremont, Michigan[3]. For the early post

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[2]A seed protectant formulation containing thiram (tetramethylthiuram-disulfide) and dieldrin (hexachloroepoxyoctahydro-endo, exo-dimenthanonaphthalene) supplied by the E. K. DuPont de Nemours and Co., Inc. Wilmington, Delaware. The gibberellin used in these studies consisted of potassium gibberellate supplied by Merck and Co., Rahway, New Jersey.

[3]The assistance of A. N. Reath, Gerber Products Company, Fremont, Mich. is gratefully acknowledged.

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mergence treatment a portion of the plots at East Lansing grown rom Delsan A-D treated seed was sprayed with a 50 p.p.m. gibberellin olution at the second true leaf stage which was approximately 10 days fter emergence. Each treatment was replicated four times as 40-foot ingle row plots spaced two feet apart. All pods with peas of market- ble maturity were hand harvested.

Plants from gibberellin treated seeds or from those that received he early post-emergence treatment of gibberellin showed pronounced egetative extension during the early growth stages. The stems were nuch longer and thinner, and the leaves lighter green in color than hose grown from non-treated seed. The root systems of treated lants were smaller and more restricted. (Fig. 1).

Fig. 1. Gibberellin, as a slurry seed treatment, promoted development of ong slender pea seedlings with restricted root systems. Left, control (no treat- nent); right, 1,000 p.p.m. of gibberellin in "Delsan A-D" applied as a slurry to ne seed prior to planting.

Neither seed treatment nor early post-emergence application of ibberellin had a significant effect on yield (Table 1). The growth timulus induced in pea seedlings by seed or post-emergence treat- nents of gibberellin had usually disappeared by harvest time and the reated plots could not be distinguished from the controls. Gibberellin eed treatments (1000 p.p.m. in a Delsan A-D slurry) at Fremont, Mich-

TABLE 1—Influence of seed and early post-emergence treatments wit gibberellin on the yield of peas

Variety	Weight of peas (pounds of pods per 40 feet of row)*		
	Control (no treatment)	Seed treatment (1000 p.p.m. in slurry)	Second true-leaf stage (100 p.p.m. as foliar spray)
Thomas Laxton...	11.5	10.0	11.2
Perfection.....	19.2	17.9	16.2

*Gibberellin treatments resulted in no significant differences in yield.

igan, reduced the stand of Thomas Laxton peas. The long, slende sparsely rooted plants that resulted from the gibberellin treatmer were more subject to wind damage. Thus while emergence was pro moted and percentage germination was not altered, post-emergenc losses were greater.

TREATMENT DURING LATE BLOOM OR EARLY POD DEVELOPMENT

Seed of Alaska, Perfection and Thomas Laxton varieties wer sown at the Horticulture Farm in East Lansing on April 10 and Pe fection and Thomas Laxton varieties at the Southern Michigan Priso Farm near Jackson, Michigan, on April 16. At each location the pea were planted in rows 2 feet apart in a randomized block design. Eac treatment was replicated 3 times for each of the 3 dates of harves

In East Lansing a plot consisted of a single row 50 feet long whi at Jackson it was two paired 50 foot rows. The plants were sprayed with a solution of gibberellin (50 p.p.m.) at a bloom or post-bloom stage. In East Lansing all three varieties were sprayed during th late bloom stages when the earliest pods were ½- to 1-inch in lengt while in Jackson only the variety Thomas Laxton was sprayed a this stage. The Perfection variety at Jackson was sprayed when th most mature pods were 2 to 2½ inches long but before the seed had begun to develop. The equivalent of about 10 grams of gibberelli per acre was applied as full bloom or post bloom sprays.

Three harvests were made for each variety at two- to four-da intervals. The first harvest was made at the time the peas reached tenderometer value near 90. The vines were pulled and pods wer picked by hand. The peas were shelled with a Scott-Sinclair portab viner. The shelled peas were then weighed and three to five sample

of tenderometer readings were made. The Perfection peas that were harvested on July 5 at both locations were graded into four standard sieve sizes (numbers 4, 5, 6, and 7) with a Sinclair-Scott pea sizer.

Post bloom application of gibberellin had an effect on the vegetative growth of the Perfection and Thomas Laxton varieties, but no effect on Alaska. The vines were taller, lighter green in color and more erect than the non-treated plants. Differences in vegetative growth induced by gibberellin were noticeably greater for the Perfection than for Thomas Laxton and were most pronounced at East Lansing.

A differential varietal response to gibberellin applied at late bloom was noted in East Lansing. Yields were lower and tenderometer readings significantly reduced in Perfection (Table 2). No yield or maturity differences were observed in Alaska or Thomas Laxton. At Jackson, where gibberellin was applied during early development of the pods, no significant differences in yield or maturity were obtained for either Thomas Laxton or Perfection (Table 3).

TABLE 2—Effects of a gibberellin spray (50 p.p.m.) during late bloom or early pod development on yield (pounds per 50 feet of row) and maturity (tenderometer) of shelled peas grown at East Lansing, Michigan

Alaska				Thomas Laxton			Perfection		
Date of harvest	Gibberellin	Yield	Tenderometer	Date of harvest	Yield	Tenderometer	Date of harvest	Yield	Tenderometer
June 18..	–	1.9	116	June 22..	4.2	82	July 3...	10.8	95
	+	1.7	114		3.7	84		8.3	90
June 20..	–	2.6	115	June 24..	5.3	89	July 5...	11.0	108
	+	2.9	118		4.7	84		8.1	100**
June 23..	–	4.1	148	June 27..	8.2	107	July 7...	13.1	137
	+	3.8	147		8.1	103		9.7	128*

* or **values for gibberellin significantly less at the 5 and 1 percent levels, respectively.

The delay in maturity of the Perfection peas, induced by a late bloom spray of gibberellin at East Lansing, is indicated by the lower percentage of peas in the largest sieve size (number 7), and the higher percentages in the smaller sizes (numbers 4 and 5) as compared with the controls. There were no differences, however, in distribution of peas in the various sieve sizes of the Perfection variety grown at Jackson and sprayed with gibberellin during early pod development (Table 4).

TABLE 3—Effects of a gibberellin spray (50 p.p.m.) during late bloom o early pod development on yield (pounds per 100 feet of row) and maturit (tenderometer value) of shelled peas grown at Jackson, Michigan

Thomas Laxton				Perfection		
Date of harvest	Gibberellin*	Yield	Tenderometer	Date of harvest	Yield	Tenderometer
June 24...	−	11.0	84	July 3.....	16.6	99
	+	10.3	86		14.8	95
June 28...	−	13.8	100	July 5.....	19.6	113
	+	13.5	99		17.6	113
June 30...	−	17.4	120	July 7.....	19.9	148
	+	16.8	123		20.5	148

*Gibberellin effects on yield and maturity were not significant.

SUMMARY AND CONCLUSIONS

Gibberellin applied as an "in slurry" seed treatment (1000 p.p.m. to field-grown Alaska, Thomas Laxton, and Perfection peas reduce the stand of plants but hastened emergence, and accelerated the earl growth of the seedlings. No effect on maturity or yield was note Sprays (50 p.p.m.) applied to peas in the second true-leaf stage resulte in a temporary acceleration in vine growth that had disappeared b harvest time, and failed to have any effect on maturity or yield.

Gibberellin sprays (50 p.p.m.) applied to peas grown at two loca tions during late bloom or during early pod development had n effect on maturity or yields except on Perfection sprayed during lat

TABLE 4—Effects of a gibberellin spray (50 p.p.m.) at late bloom (Eas Lansing) and during early pod development (Jackson) on sieve size of peas expressed as a percent of total yield of shelled Perfection pea harvested July 5

Sieve size	East Lansing		Jackson	
	Control	Gibberellin	Control	Gibberellin
No. 4.....	11	15	12	12
No. 5.....	14	18	18	17
No. 6.....	19	21	30	28
No. 7.....	56	46	40	43

bloom. In the Perfection variety, yields were consistently lowered and maturity was significantly delayed as measured by tenderometer values. The delay in maturity was confirmed by a lower percentage of peas in the largest sieve size and correspondingly higher percentages in the smaller sieve sizes.

The data suggest that the accelerations in growth induced by gibberellin seed treatments or early post-emergence sprays were not reflected in favorable differences in maturity or yield of processing peas. Sprays during late bloom may in some instances result in a delay in maturity reflected in higher quality as compared to controls. Further studies for appraisal of the beneficial effects of gibberellin on pea quality, as opposed to the deleterious effects on yield, must be conducted before its economic usefulness can be established.

LITERATURE CITED

Barber, H. N., W. D. Jackson, I. C. Murfet and J. I. Sprent (1958). Gibberellic acid and the physiological genetics of flowering in peas. Nature. 182: 1321-1322.

Bonde, E. K. and T. C. Moore (1958). Effects of gibberellic acid on the growth and flowering of telephone peas. Physiologia Plantarum. 11: 451-456.

Bukovac, M. J. and S. H. Wittwer (1956). Gibberellic acid and higher plants: I. General growth responses. Mich. Agr. Expt. Sta. Quart. Bul. 39: 307-320.

Wittwer, S. H. and M. J. Bukovac (1957). Gibberellin and higher plants: VIII. Seed treatments for beans, peas, and sweet corn. Mich. Agr. Expt. Sta. Quart. Bul. 40: 215-224.

SOME RECENT TRENDS IN THE MICHIGAN ICE CREAM INDUSTRY

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PRODUTION OF ICE CREAM in Michigan, on a per capita basis, has not been keeping pace with the national average nor with production in nearby states. Numerous hypotheses have been advanced to explain this trend. Some believe that imports from other states are growing in comparison to Michigan's exports. Some believe that prices have declined more in other states than in Michigan. Some feel that trends in frozen dairy desserts, other than ice cream, have been a factor. Some believe that chain store procurement practices, on a regional basis, are a cause. Others advance additional hypotheses. Many more facts than are now known would be needed to determine the most important factors affecting this trend. Considerable research would be needed.

This article presents a few facts and figures that relate to the subject. First, data are presented to verify beliefs among people in the industry that Michigan production has not kept pace with others. Second, comparisons are made with other areas in the production of all frozen desserts. Third, the relative importance of ice cream, compared with all frozen desserts, is presented for different areas. Fourth, some research findings from a food purchase study are presented.

Ice cream production

Table 1 provides information on the per capita production of ice cream in Michigan compared with other areas. Per capita production in Michigan reached a peak in 1953 and declined thereafter to the 1950 level. Production in Ohio reached a peak in 1957, and production in 1957 in Indiana and Wisconsin was near the peak of 1955. In Illinois, the trend in recent years has been upward compared with

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TABLE 1—Per capita production of ice cream, in gallons, by years since 1950, Michigan, other East North Central States, other regions, and U.S.

	1950	1951	1952	1953	1954	1955	1956	1957
Michigan...	4.04	4.11	4.26	4.44	4.09	4.21	4.11	4.04
Ohio.....	4.23	4.39	4.52	4.50	4.28	4.47	4.54	4.62
Indiana.....	4.33	4.49	4.66	4.97	4.84	5.27	5.28	5.25
Illinois.....	3.66	3.75	3.65	3.31	3.20	3.30	3.44	3.46
Wisconsin ..	4.68	4.78	5.07	5.31	5.32	5.54	5.49	5.51
E. N. C.....	4.09	4.20	4.29	4.31	4.13	4.31	4.34	4.35
W. N. C....	4.07	3.96	4.15	4.17	4.18	4.22	4.20	4.08
No. Atl.....	4.34	4.45	4.37	4.67	4.49	4.79	4.75	4.81
South.....	2.77	2.74	2.75	2.77	2.74	2.77	2.77	2.70
West.....	3.59	3.65	3.83	3.67	3.43	3.37	3.53	3.56
U. S.....	3.68	3.71	3.81	3.82	3.70	3.83	3.83	3.82

Source: Computed from data compiled by U.S.D.A. and Bureau of the Census, providing production and population, respectively.

Michigan's downward trend. In general, output per capita in Michigan kept pace with other East North Central States from 1950 to 1953, but deviated from 1953 to 1957. There were, however, major sections of the country which made no net gains from 1950 to 1957, or were somewhat similar to Michigan's trend. The large area of the nation west of the Mississippi and the South made no gains from 1950 to 1957.

Frozen Dessert Production

Table 2 provides information on per capita production of frozen desserts. This includes ice cream, milk sherbet, ice milk, water ices, other frozen dairy products, and mellorine (the recently introduced substitute for ice cream which replaces butter fat with vegetable fat).

These data indicate that Michigan has been rather unique in having a fairly substantial decline in per capita production in recent years. Ohio has had a fairly steady upward growth. Indiana and Wisconsin increased to 1955 and levelled off. Illinois levelled off after 1952. Most of the regions of the United States have witnessed a fairly steady upward growth in production.

Table 3 gives the ratio of ice cream production to frozen dessert production. One might look to this table for a clue as to whether the trend in the ratio may be associated with the trend and level of actual output of ice cream. In Michigan, as well as other areas, the ratio has been on the decline.

TABLE 2—Per capita production of frozen desserts, in gallons, by years since 1950, Michigan, other East North Central States, other regions, and U.S.

	1950	1951	1952	1953	1954	1955	1956	1957
Michigan...	4.35	4.50	4.76	5.07	4.78	4.90	4.77	4.70
Ohio.....	4.66	4.90	5.17	5.32	5.21	5.57	5.68	5.82
Indiana.....	4.65	4.66	4.89	5.23	5.33	5.77	5.79	5.70
Illinois.....	4.35	4.64	4.98	4.95	4.75	4.90	4.96	4.90
Wisconsin ..	4.86	5.04	5.50	5.91	5.60	6.35	6.28	6.31
E. N. C.....	4.53	4.73	5.03	5.22	5.09	5.35	5.37	5.36
W. N. C....	4.62	4.66	5.25	5.47	5.57	5.62	5.65	5.56
No. Atl.....	4.57	4.73	4.94	5.08	4.92	5.27	5.24	5.34
South.....	3.28	3.43	3.64	3.91	4.07	4.19	4.29	4.26
West.....	4.85	4.94	5.21	5.28	5.26	5.30	5.44	5.51
U. S.....	4.20	4.34	4.61	4.81	4.80	4.99	5.04	5.05

Source: Computed from data compiled by U.S.D.A. and Bureau of Census, providing production and population, respectively.

In Indiana, where the trend has been upward and the level of ice cream production has been high, the ratio of ice cream to frozen dessert production has remained high. In contrast, in Ohio, where the trend and level were similar, the ratio of ice cream to frozen desserts has declined fairly rapidly. Data from these two states illustrate that one cannot always conclude that a decline in the ratio adversely affects ice cream output. Additional illustrations can be observed in Table 3.

TABLE 3—Ratio of ice cream to frozen dessert production, 1950-1957, Michigan, other East North Central States, other regions, and U.S.

	1950	1951	1952	1953	1954	1955	1956	1957
Michigan...	92.8	91.4	89.3	87.6	85.6	86.0	86.3	85.8
Ohio.....	90.9	89.7	87.3	84.6	82.1	80.2	80.0	79.3
Indiana.....	93.2	96.2	95.3	95.0	90.8	91.2	91.3	92.2
Illinois.....	84.2	80.7	73.1	66.8	67.3	67.4	69.3	70.7
Wisconsin ..	96.4	94.8	92.2	89.9	88.6	87.2	87.5	87.4
E. N. C.....	90.4	89.0	85.4	82.5	81.0	80.6	80.9	81.2
W. N. C....	88.0	85.0	79.1	76.3	74.9	75.1	74.4	73.5
No. Atl.....	95.1	94.0	92.6	91.8	91.2	91.0	90.8	90.2
South.....	84.5	79.8	75.6	70.9	67.4	66.0	64.6	63.5
West.....	74.1	73.9	73.5	69.5	65.3	63.5	64.9	64.6
U. S.....	87.6	85.4	82.5	79.5	77.1	76.7	76.1	75.5

Source: Computed from data compiled by U.S.D.A.

Factors Affecting Consumption for Home Use

Data are available from the M.S.U. Consumer Panel on purchases of ice cream and frozen dairy desserts for home use. The Panel consisted of about 275 families in Lansing who reported weekly on their food purchases. The sample was drawn so as to be representative of the city. Data have been tabulated from mid-1951 to mid-1958. For all practical purposes the data can be interpreted as representing ice cream purchases since very little of the sherbets, ices, and similar items are bought for home use. Instead they are consumed in restaurants, at drive-ins, and other places away from home.

Annual average quantities purchased, prices, incomes of Lansing people, and percentage of families buying weekly are shown in Table 4.

TABLE 4—Frozen dairy desserts: Quantity, price, and percent buying; consumer incomes, M.S.U. Consumer Panel, mid-1951 to mid-1958

	Ave. pints per person weekly Pt.	Ave. price per pint $	Average per capita income weekly $	Percent of families buying weekly %
1951 (last half)	.331	.281	25.44	38.5
1952	.350	.290	25.79	43.2
1953	.410	.278	29.25	44.4
1954	.418	.258	28.96	43.2
1955	.451	.241	32.55	41.2
1956	.474	.229	32.26	39.3
1957	.526	.211	32.56	40.7
1958 (first half)	.544	.199	32.82	40.5

These data show that purchases for home use have increased by two-thirds over the seven-year period. This is a substantial increase. Prices declined by about one-third, and this price decrease can be matched by few if any foods. During this time period there were no great changes in percentage of families buying weekly. There was, however, a fairly sharp increase in purchasing power from 1951 to 1955, but a levelling off thereafter.

In Fig. 1 the data for this time period are shown by 4-week periods. Added to the above data is average temperature at the East Lansing weather station. Temperature changes account for most of the seasonal changes in purchases.

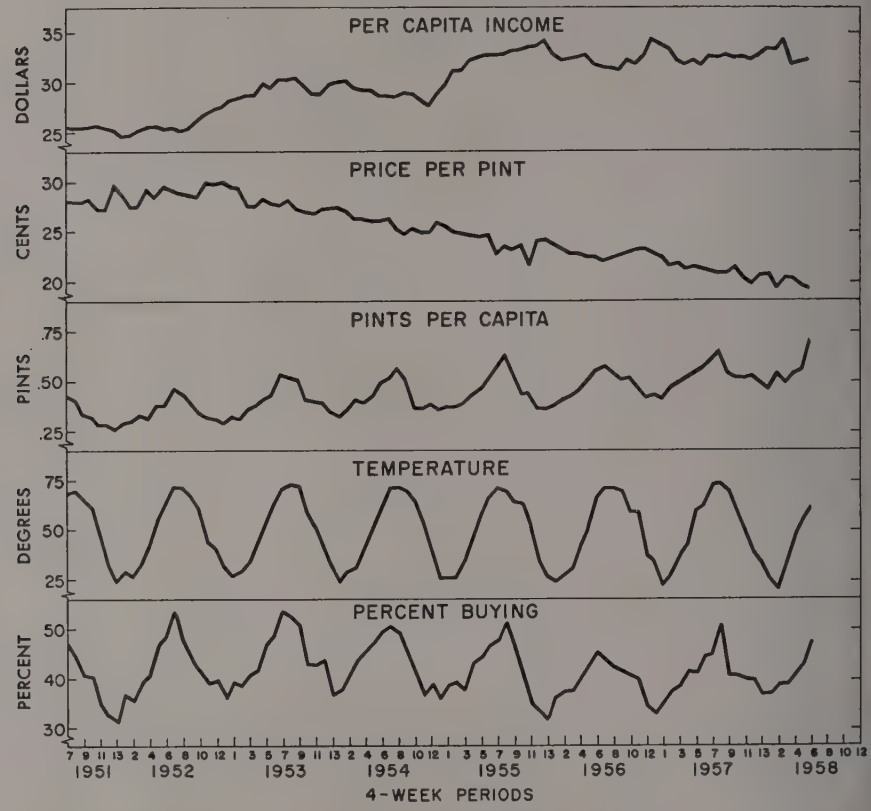

Fig. 1. Frozen dairy desserts: price, quantity purchased for home use, and percent buying weekly; consumer incomes in Lansing and temperature in East Lansing. MSU Consumer Panel by 4-week periods, mid-1951 to mid-1958.

From these data it is possible to determine how much effect price, incomes, and temperature have had in determining changes in the quantity purchased. These calculations indicate that a 10 percent change in price results in a 9 percent change in quantity purchased, in the opposite direction. A 10 percent change in income results in a 5 percent change in quantity, in the same direction. A 10 percent change in temperature results in a 4 percent change in quantity, in the same direction.[1] These relationships pretty well account for the seasonal and trend changes in quantity over the 1951-58 period.

The percentage of families buying weekly follows closely the changes in temperature, with a 1 percent change in temperature resulting in a 1 percent change in percentage buying.

SUMMARY

Per capita production of frozen dairy desserts in Michigan has not increased in the past 6 or 7 years. Consumer panel data in one city indicates that per capita home use of these products has increased by about two-thirds over this time period. These data would indicate that there have been major shifts in consumption habits and associated with this there probably have been major shifts in retail outlets to grocery stores from other outlets. The data provide no conclusive evidence or trends in per capita consumption both at home and away from home to use in comparative analysis with output data.

[1]The multiple regression equation was:
$x_1 = .481437 - 1.608870x_2 + .006659x_3 + .003221x_4$
x_1 = ave. pints per capita weekly
x_2 = ave. price per pint
x_3 = ave. per capita income weekly
x_4 = ave. temperature
The mean values were: .436 pints, $.250, $30.04, and 48.66 degrees
The t-ratios were: 6.66, 2.53, and 13.13, respectively
$R^2 = .833$; number of 4-week periods equalled 91

For an earlier analysis see G. G. Quackenbush and J. D. Shaffer, "Factors Affecting Purchases of Ice Cream For Home Use," Tech. Bul. 249, M.S.U. Agr. Expt. Sta., April, 1955.

A RAPID METHOD FOR DETERMINING THE PROTEIN AND MILK SOLIDS-NOT-FAT CONTENT OF ICE CREAM AND ALLIED PRODUCTS

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THE MOJONNIER ANALYSIS constitutes the primary means of assaying ice cream for its fat, total solids and solids-not-fat (SNF) content. The percentage of milk solids-not-fat (MSNF) in ice cream can be estimated from results of direct determinations for its lactose, protein and ash content. However, the methods employed to get these values are not only time consuming but present technical difficulties beyond the scope of many control laboratories. The determination of the percentage lactose in ice cream is difficult at best, but becomes involved when such sugars as glucose and/or invert sugars are added.

A fairly close approximation of the MSNF content of ice cream can be found by subtracting the amount of sugar added from the SNF value. Although this technique furnishes a practical solution to the problem, it is subject to error in measurement and estimation. Consequently, the need of a rapid, accurate method for determining the MSNF content of ice cream becomes imperative.

SPECULATION ON A QUICK METHOD

The correlation between the protein and SNF composition of milk is relatively high[1]. Therefore, a rapid method by which the protein content of ice cream can be determined should provide a satisfactory basis for estimating the MSNF content of the ice cream.

The standard Kjeldahl nitrogen procedures for determining protein are involved and require specialized equipment. Thus, this method seemed to offer no possibilities. However, the somewhat ancient,

[1]Specht, L. W., J. R. Brunner, D. E. Madden and N. P. Ralston (1956). The influence of several factors on the protein and solids-not-fat content in the milk of jersey cows. J. Dairy Sci., 39:1337-1341.

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but highly respected, formol titration embraces many desirable characteristics for such a testing method. The technique consists in titrating a fluid sample to the phenolphthalein end-point with a standard alkali solution before and after the addition of a small amount of formol. The operations are no more involved than those of the familiar acidity titration.

A procedure is outlined and data are presented to illustrate the applicability of this test to the determination of protein and/or MSNF in ice cream and allied products.

METHOD

The procedure for conducting the formol titration, as adapted from the method of Richardson *et al.*[2], was as follows:

a) To a 10 g. sample of mix or melted ice cream add 10 ml. of water and 6-8 drops of a 2% phenolphthalein solution;
b) Titrate to a faint pink end-point (pH 8.4) with standard 0.1N NaOH solution;
c) To this neutralized sample, add 3 ml. of formol (37-40% formaldehyde solution) and 1 ml. of saturated potassium oxalate solution;
d) Stir the mixture and re-titrate to the same pink end-point;
e) Record the ml. of the standard base solution used in the second titration minus the ml. of base required to titrate a reagent mixture consisting of 20 ml. of water, 3 ml. of formol, and 1 ml. of oxalate solution.

The blank-corrected titer represents the value used in computation and is equivalent to 1.80 percent protein per ml., based upon Kjeldahl determinations for protein in the same samples. Assuming, then, that protein constitutes approximately 40 percent of the SNF content of normal mixed milk[3], the concentration of MSNF in ice cream can be expressed by the following equations:

(A) ml. of O.1N NaOH (blank-corrected) x 1.80 = % Protein

or

$$\text{(B) ml. of O.1N NaOH (blank-corrected) x } \frac{1.80}{40} \text{ x } 100 = \% \text{ MSNF}$$

[2]Richardson, G. A., J. O. Young, S. H. Dalal, S. J. Pearce and P. N. Narula (1953) The use of rotein test (formol titration) to estimate the solids-not-fat content of milk. Proc. 34th Ann. Meet., Western Div., Am. Dairy Sci. Assoc.

[3]Overman, O. R., O. F. Garrett, K. E. Wright and F. P. Sanmann (1939). Composition of milk f Brown Swiss cows. Ill. Agr. Expt. Sta. Bul. 457.

EXPERIMENTAL

Three ice cream and sherbet mixes of carefully controlled composition were prepared on a pilot scale and analyzed by the Mojonnier method for fat and total solids. These same samples were analyzed also by the Kjeldahl (standard) and formol titration methods for protein. An effort was made to use milk solids in which the protein approximated 40 percent of the SNF. The results of these analyses and calculations are shown in Table 1. The reproducibility of the formol titration method for determining the protein and MSNF content of ice cream mixes by the respective equations was tested by making 10 determinations on each of the samples. The results of these analyses are given in Table 2.

TABLE 1—The percentage of constituents in prepared ice cream and sherbet samples as analyzed by various methods. (Mean values of 10 analyses.)

Component	The percentages of constituents in		
	Ice cream		Sherbet
	Mix A	Mix B	Mix C
	%	%	%
Fat*	12.02	12.11	2.47
Total solids (TS)*	39.20	41.10	40.24
Solids-not-fat (SNF)**	27.18	28.99	37.77
Sugar	15.00	18.00	31.70
Protein†	4.88	4.44	2.31
Protein‡	4.90	4.53	2.27
Milk solids-not-fat (MSNF)†	12.18	10.99	6.07
Milk solids-not-fat (MSNF)§	12.25	11.34	5.68

* Mojonnier analyses
** Calculated from fat and total solids data
† Calculated from Kjeldahl N values
‡ Calculated from formol titration values using equation (A)
§ Calculated from formol titration values using equation (B)

DISCUSSION

The protein and MSNF values for the experimental mixes, as determined by the formol titration method outlined in this paper, compared favorably with protein values based on the Kjeldahl method and the known values for MSNF. Analysis of variance and standard deviation indicate that the method is sufficiently accurate and reproducible for routine use in the control laboratory.

TABLE 2—The consistency of results secured in determining the percentage of protein and MSNF in ice cream and sherbets by the formol titration method

Trial No.	The percentage of protein and MSNF in					
	Ice cream				Sherbet	
	Mix A		Mix B		Mix C	
	Protein[1]	MSNF[2]	Protein	MSNF	Protein	MSNF
	%	%	%	%	%	%
1.....	4.91	12.28	4.50	11.25	2.25	5.63
2.....	4.90	12.25	4.50	11.25	2.31	5.78
3.....	4.82	12.05	4.62	11.55	2.30	5.75
4.....	4.85	12.13	4.55	11.38	2.25	5.63
5.....	4.90	12.25	4.51	11.28	2.30	5.75
6.....	5.02	12.55	4.50	11.25	2.24	5.60
7.....	4.87	12.23	4.51	11.28	2.25	5.63
8.....	4.90	12.25	4.55	11.38	2.30	5.75
9.....	4.89	12.23	4.50	11.25	2.25	5.63
10.....	4.91	12.28	4.60	11.50	2.25	5.63
Avg. ..	4.90	12.25	4.53	11.34	2.27	5.68

[1] Calculated from equation (A)
[2] Calculated from equation (B)

Conceivably an ice cream mix could be formulated in which the MSNF, as determined by the formol titration, could not be determined accurately. The incorporation of whey solids or specialized milk protein preparations would upset the normal ratio of protein to MSNF, the postulation upon which equation (B) is based. Similiarly, variations in the protein/MSNF ratio of the milk used to manufacture mixes could result in erroneous values for MSNF. However, mixes are manufactured from a supply of mixed milk, a factor which would tend to minimize this source of error. Because of the existence of this possible source of error, a more realistic approach, and one more nearly indicative of the nutritive value of the ice cream, would be the determination of the total protein content. This important component is determined quite accurately by the formol titration and equation (A).

Normally, procedures and temperatures encountered in the processing of mixes do not alter the reliability of the formol titration method. High pasteurization temperatures (190° F. for 30′), conducive to whey protein denaturation, do result in lower formol-protein values.

SUMMARY

A formal titration method for the rapid determination of the protein and/or MSNF content of ice cream mixes has been outlined and discussed. The analytical data from three samples of mix are presented and indicate that the method is sufficiently accurate to be used in routine determinations.

The percentage of protein in ice cream may be found by use of the equation:

(A) ml. of 0.1N NaOH (blank-corrected) x 1.80 = % Protein

The percentage of MSNF in ice cream may be found by use of the equation:

$$\text{(B)}\quad \frac{\text{ml. of 0.1N NaOH (blank-corrected) x 1.80}}{40} \times 100 = \%\ \text{MSNF}$$

EFFECT OF POLYETHYLENE MULCHES, STARTER SOLUTION AND KIND OF TRANSPLANT ON YIELDS OF SWEET PEPPERS

By J. D. DOWNES, R. HESLIP and S. HONMA
DEPARTMENT OF HORTICULTURE

EARLINESS AND TOTAL MARKETABLE YIELD has been increased in a number of crops by mulching with black polyethylene (Carolus, et al, 1958; Emment, 1956; Rowe-Dutton, 1957). This material absorbs heat, and prevents loss of surface soil moisture, which may contribute to rapid development of roots and increased nutrient absorption (Tiessen, 1953).

Trials with containers used in growing transplants have demonstrated that preservation of the intact root system aids in early resumption of growth after transplanting (Knott et al, 1929; Thompson, 1949), and often leads to earlier production (Brown, 1950; Knott et al, 1929). The value of fertilizer solutions applied to transplants has been demonstrated in a number of experiments (Baker, 1937; Reath, 1952; Sayre, 1939).

EXPERIMENT I

Methods

A trial with peppers was conducted in 1958 at the Sodus Horticultural Experiment Station in southwestern Michigan involving the following factors:

A. 1.5 mil black polyethylene mulch.
B. 1.5 mil aluminum pigmented polyethylene mulch.
C. Ordinary cultivation to maintain weed control.
1. Water used in transplanting banded plants (grown in 3″ x 3″ wood veneer bands).

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2. Water used in transplanting "stick" plants (ordinarily grown in beds without containers, but in this experiment banded plants with bands removed and soil shaken from the roots were used).
3. 10-50-10 soluble fertilizer starter solution used in transplanting banded plants.
4. 10-50-10 soluble fertilizer starter solution used in transplanting "stick" plants.

All possible combinations of treatments A, B and C with 1, 2, 3 and 4 were employed in a factorial experiment arranged in a split plot design. The mulches and cultivation, as main plots, were randomized in three replications with the type of transplant x starter versus water combinations (1-4 above) serving as subplots. The subplots consisted of single rows of 10 plants spaced 18 inches apart in rows 3 feet apart.

All banded plants received an application of either starter solution or water before transplanting, while the "stick" plants were treated as they were set in the field. Both banded and stick plants were given the same quantities of water or fertilizer solution. Three foot widths of plastic were used to cover the mulched areas, and the plants set in holes cut in the film.

The variety Keystone Resistant Giant was used. A 5-10-20 fertilizer at the rate of 600 pounds per acre was applied in preparing the land for planting. Soil tests showed the pH to be 6.2, available P to be 68 pounds per acre, and available K to be 250 pounds per acre. The plants were set in the field on June 6, and the crop was harvested over the period August 4 through September 23. At each harvest the peppers were graded into No. 1, No. 2 and cull fruits.

EXPERIMENT II

Methods

A field trial with peppers comparing cultivation with the effects of mulching with plastic films was conducted at East Lansing. The four treatments listed below were compared in a randomized block design with three replications.

A. Cultivated (single row of plants).
B. Mulched with aluminum covered polyethylene (1.5 mil) strips 30 inches in width (single row of plants).

C. Mulched with black polyethylene (1.5 mil) strips 2 feet in width (single row of plants).

D. Mulched with black polyethylene (1.5 mil) strips 4 feet in width (two rows of plants).

Rows were placed 3 feet apart except in treatment D where twin rows were spaced 2 feet apart, and plants were spaced 18 inches in the row. Each row in every plot contained 13 plants. Flat-grown transplants of the variety Yolo Wonder A were set through holes made in the plastic on June 10.

Six hundred pounds per acre of 5-20-20 fertilizer was broadcast and disked in prior to planting. Harvesting began July 29 and ended October 12.

RESULTS AND DISCUSSION

Mulching versus Cultivation

In the trial at Sodus the peppers graded No. 1 and No. 2 were added together to obtain the marketable yields. Those harvested in the first two pickings were designated as the early crop. There was no consistent difference between the mulched plots in early yields, but they produced significantly less than the cultivated plots (Table 1). The average early yield from the six mulched plots was 6,599 pounds per acre, and from the cultivated plots 8,317 pounds per acre, representing an increase of 12.6 percent in favor of the cultivated plots.

Mulching appeared to favor early vegetative development rather than early fruiting. The plants mulched with black polyethylene were darker green than those on cultivated plots, while those mulched with aluminum pigmented polyethylene were much lighter in color.

TABLE 1—Effects of two mulching materials and cultivation on yields in pounds of keystone resistant giant peppers

Harvest period	Black polyethylene	Aluminum pigmented polythylene	Cultivated	Average
Early (8/4-8/13)...	7,002	6,195	8,317*	7,171
Late (8/14-9/23)..	13,036	16,763	12,406	14,069
Total (8/4-9/23)...	20,038	22,958	20,723	21,240

*Difference between polyethylene mulches and cultivation significant at 5 percent level.

The temperature under both the aluminum and black plastic mulch, at a depth of 4-5 inches, was 3-5 degrees F. higher than at the same depth in the cultivated plots.

Differences in total yields were found to be unrelated to any of the mulching or cultivation treatments at Sodus.

At East Lansing early yields were not significantly increased by plastic mulches; but a significant difference among the treatments, with respect to total yields, was found as shown in Table 2. Partitioning of the treatment variance revealed that three means were significantly different, viz. $\overline{D} > \overline{BC} > \overline{A}$, although the LSD_{05} indicated that only the two means viz. $D > A$ were significantly different. Apparently the use of the 4-foot plastic increased total yields 41 percent compared to cultivation, and may also have been superior to the 2-foot strips. There is no evidence that in 2-foot strips there was any difference between the black and the aluminum covered polyethylene.

The possible benefits of plastic have been enumerated before (Carolus et al, 1958; Emmert, 1956; Rowe-Dutton, 1957) and include the increased volume of undisturbed soil available to plant roots, increased soil temperature to a depth of 4 to 6 inches, decreased soil moisture losses, reduced compaction, improved soil aeration, and a reduction in the disturbance of plant roots occasioned by the necessity of cultivation for weed control.

Peppers in these trials differed from tomatoes and melons in other trials (Carolus et al, 1958) with respect to response to mulching with plastic. It thus appears that the warm season crops may not be expected to respond alike to efforts to improve their microclimate, but that field trials must be employed to evaluate specific responses, particularly those of economic importance.

TABLE 2—Effect of polyethylene mulches on early and total marketable yields in pounds per acre of Yolo Wonder A pepper in Central Michigan (East Lansing, 1958)

Treatments	Early yields	Total yields
A. Scraped	8,712	22,143
B. Aluminum polyethylene mulch, 2′ strips	9,801	26,862
C. Black polyethylene mulch, 2′ strips	10,527	28,314
D. Black polyethylene mulch, 4′ strips	13,576	31,218
LSD_{05}	N.S.	5,953

Type and Treatment of Transplants

Stick plants produced much lower yields than banded plants chiefly because of the very low yields obtained when water instead of starter was used in transplanting. The response to the starter solution, shown in Table 3 suggests that placing a non-toxic concentration of readily available fertilizer in the root zone may have compensated in large measure for the reduced root surface possessed by stick plants. Early yields of stick plants were almost doubled by using 10-50-10 starter solution, but starter had no significant influence on the yield of banded plants.

TABLE 3—Effects of type of transplant and transplanting treatment on yields in pounds per acre of keystone resistant giant pepper

Type of transplant	Transplanting treatment					
	Water		Starter		Average	
	Early	Total	Early	Total	Early	Total
Band	9,057	22,061	8,540	23,437	8,799	22,749
Stick	3,765	17,973	7,325	21,490	5,545	19,732
Average	6,411	20,017	7,933	22,464	7,171	21,240

Early Yields:
L.S.D.$_{05}$ for type of plant x treatment combinations = 2,807 lbs. per acre.
Difference between average banded and average stick plant yields significant by F test at .01 level of P.
Difference between average watered and average starter treated plant not significant by F test at .05 level of P.
Total Yields:
At P.$_{05}$ average for bands>average for stick.

Banded plants produced about 15 percent higher total yields than stick plants. Apparently stick plants receiving water at transplanting had caught up with those receiving starter by the end of the harvest season, judging by the lack of significance for the differences between the subplot total yields.

At 5¢ per pound, the price paid by area processors in 1958, the average 3,017 pounds increase in yield obtained by the use of bands would have increased gross returns per acre about $151.00. This would provide about 1.6 cents per plant toward growing the 9,680 plants required per acre spaced as they were in this experiment.

The cost of bands at $5.50 per thousand would be about $54.00 per acre, leaving about $97.00 for the extra cost of growing and setting

banded plants, and profit. Although a return of this magnitude might not be frequently realized by many growers, owing in part to other limiting factors, at prices in excess of 5¢ per pound proportionately more money could be returned to the grower. Fresh market prices are normally above this figure.

Mulching had no influence on the effects of type of transplant or starter solution with respect to either early or total yields in this experiment.

SUMMARY

A. Mulching:

1. Mulching appeared to promote vegetative growth at the expense of early fruiting in southwestern Michigan and had no effect on total marketable yields.
2. At East Lansing early yields of Yolo Wonder A peppers were not significantly increased by mulching, but total yields were increased 41 percent over cultivation by using 4-foot strips of plastic in which twin rows were planted 2 feet apart.

B. Type and Treatment of Transplants:

1. Early yields of stick plants were almost doubled by using 10-50-10 starter solution, and with starter solution produced as much as banded plants.
2. Early yields from transplants grown in bands were not increased by the use of starter solution at transplanting.
3. The use of starter solution did not increase total yields from any type of transplant.
4. Band-grown transplants produced about 15 percent higher total yields than stick plants.
5. Neither type of transplant nor starter solution influenced the yield obtained from mulching.

LITERATURE CITED

Baker, C. E. (1937). Early fruiting of tomatoes as induced by use of soluble phosphate. Proc. Amer. Soc. Hort. Sci. 35:668-672.

Brown, H. D. (1950). Clay pots versus veneer bands. Market Growers Jour.

Carolus, R. L. and J. D. Downes (1958). Studies on muskmelon and tomato responses to polyethylene mulching. Mich. Agr. Expt. Sta. Quart. Bul. 40(4): 770-785.

Emmert, E. M. (1956). Polyethylene mulch looks good for early vegetables. Market Growers Jour. 85(5):18-19.

Knott, J. E. and C. D. Jeffries (1929). Studies with containers for plant growing. Pa. Agr. Expt. Sta. Bul. 244.

Reath, A. N. (1952). The effect of starter solution chemicals and certain other cultural practices on growth and yield of tomatoes, sweet corn and snap beans. Thesis for M.S. degree, Mich. State Col., 62 pp.

Rowe-Dutton, Patricia. (1957). The mulching of vegetables. Commonwealth Bur. Hort. and Plantation Crops. Tech. Comm. No. 24.

Sayre, Charles B. (1939). Use of nutrient solutions and hormones in the water for transplanting tomatoes, and their effect on earliness and total yields. Proc. Amer. Soc. Hort. Sci. 36:732-736.

Sheldrake, Raymond, Jr. (1958). Black plastic: magic carpet for truck farmers. Farm Jour., May.

Thompson, H. C. (1949). *Vegetable Crops.* 4th Ed. McGraw-Hill Book Company, Inc.

Tiessen, Herman. (1953). Starter solutions and polyethylene covers. Unpublished data.

SOME INDICATIONS OF HOMEMAKERS' KNOWLEDGE ABOUT FOOD BUYING AND ATTITUDES TOWARD FOOD BUYING INFORMATION[1]

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THIS STUDY WAS BASED largely on a short quiz conducted by mail. The survey tested homemakers' knowledge with respect to **eggs, meat, beef grades, reconstituted non-fat dry milk, apple grades, and general food costs.**

The study was intended primarily to benefit Michigan's Marketing Information for Consumers (MIC) program and similar extension programs in other states. It is hoped the information will also be of value to others interested in the consumer food market, especially as related to the specific products included in the survey.

Specifically the purpose of the study was to get at least partial answers to the following questions: How well informed are homemakers with respect to specific areas of food buying? Is there a difference in the level of information about food buying among socio-economic groups? Is the level of information or the attitude toward a consumer information program related to familiarity with the existing Marketing Information for Consumers (MIC) program? Is it possible to obtain useful information about homemakers' knowledge of food buying by means of a mail survey?

Also, as part of a broader evaluation of the extension program in consumer information, it is hoped to use the data of this survey as a bench mark against which changes in the level of consumers' knowledge about food buying can be measured after being exposed to the MIC program for a period of time.[2]

[1]This report is based upon M.S. thesis by Mary Strickland Holmes (1958), Some indications of level of knowledge and opinions of Michigan homemakers about food buying, Dept. of Agr. Econ., Mich. State Univ., East Lansing.

[2]Other reports from this evaluation project have included:
—Borton, R. E. and J. D. Shaffer (1958). The audiences for information releases by the Michigan Marketing Information agents through newspaper, television and radio, Dept. of Agr. Econ., Mich. State Agr. Expt. Sta. Quart. Bul. 41:24-36.
—Gillespie, Marcia M. and J. D. Shaffer (1958). Consumer evaluation of food marketing information, Dept. of Agr. Econ., Mich. State Agr. Expt. Sta. Quart. Bul. 41:52-61.
—Mackey Marjorie Boyts and J D. Shaffer (1958). Marketing information for restaurants, hospitals and schools, Dept. of Agr. Econ., Mich. State Agr. Expt. Sta. Quart. Bul. 41:41-42.

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The Questionnaire

The questionnaire used in this survey consisted primarily of statements to which the respondent was asked to check one of three responses: agree, disagree, or no opinion. Some of the statements were simply matters of opinion but many could be scored as correct or incorrect. In addition a set of questions was included on the socio-economic characteristics of the family.

Each individual question is listed on pages 655-658 in the order in which it appeared in the questionnaire along with the distribution of responses to each question or statement.

The Sample

An initial questionnaire was mailed in October 1957 to 4,000 homemakers in Michigan. This was followed by two reminders, each including a questionnaire. A random sample of 1,000 addresses was drawn from each of the city directories of Muskegon, Flint, Grand Rapids and Kalamazoo. Taking proper account of the vacant addresses the rate of response was about 50 percent. Since this rate of return is good as mail surveys go, it indicates that answers to quiz questions can be obtained by mail survey if put to the respondent in terms of opinion questions.

Non-Response Bias

In addition to the mail survey, 332 of the 457 non-respondents in Kalamazoo were interviewed in person in order to get some estimate of the nature of any existing non-response bias. Sixteen out of the 30 statements dealing with the level of knowledge were found to be significantly different based upon a Chi-square test. In 11 of the 16 significantly different cases, a larger percentage of homemakers answered the questions correctly in the mail survey than in the personal interviews. This indicates the mail survey generally overestimates to some degree the overall level of knowledge.

Index of Knowledge

It was necessary to determine the best measure of the level of knowledge in respect to each of the statements and areas. The percent of homemakers responding correctly to a statement is not the best estimate of the percent who knew the answers because of the possibility of guessing. Several assumptions were made. One assumption

was that some of the homemakers guessed at the answer and chances were that half of those who guessed would check the correct answer and half would check the incorrect answer.

It was further assumed that those who checked "no opinion" actually did not know the answer and did not guess. Thus, the best estimate of the number who guessed is the number who checked the wrong answer and the best estimate of those who knew the correct answer would be the percent wrong subtracted from the percent right. This measure has been called the Index of Knowledge.

Knowledge About Food Buying Information

The homemakers' knowledge was fairly low in all six selected areas of information. With a total of four questions each in the Eggs, Meat Buying and Meat Grades areas and three in the remaining ones, not more than one-third of the homemakers had adequate knowledge to correctly respond to three or four of them in any area except eggs. The homemakers knew the most about egg buying and the least about apple grading and the economic aspects of food costs. As shown in Table 1, less than 3 percent of the homemakers answered all three questions correctly in each of these last two areas.

TABLE 1—Number and percent of homemakers with different numbers of correct responses for each area of information

Areas of information	Number of correct responses									
	0		1		2		3		4	
	No.	%	No.	%	No.	%	No.	%	No.	%
Eggs	149	8	281	15	522	28	670	35	262	14
Meat buying	296	16	517	27	555	30	416	22	100	5
Meat grades	254	14	449	24	552	29	528	28	103	5
Marbling in beef	391	21	464	25	434	23	595	31	—	—
Non-fat dry milk	515	27	378	20	561	30	430	23	—	—
Apples	926	49	735	39	199	11	24	1	—	—
Food costs	945	50	612	33	289	15	38	2	—	—

Eggs

It has been found through consumer preference studies that most homemakers have the knowledge concerning eggs to correctly select top quality eggs when broken from the shell, but there is incomplete

knowledge and some confusion regarding grading terminology. They often incorrectly associate facts such as size, storage and color of the shell with the requirements for graded eggs. The homemaker also incorrectly connects high quality with the term "fresh". Using the Index of Knowledge as an estimate, 41 percent of the homemakers have false information concerning the term "fresh" eggs. They incorrectly concluded that those eggs labelled "fresh" must also be Grade A.

Meat

When the names of specific cuts of meat were included in a statement, few homemakers understood them or were able to answer them correctly. In one statement involving the terms Boston Butt and Picnic Shoulder, only 21 percent of the homemakers were estimated by the Index of Knowledge to know the right answer. In another statement concerning the relative amounts of lean meat to bone and fat in the Butt Portion and the Butt Half, only 5 percent of the homemakers knew the correct answer.

The term "marbling" as indicated in previous studies is not understood by most consumers. Only 24 percent of the homemakers understood the term "marbling" in meat and only 43 percent knew that it was not the fat around the edge of beef.

Generally, the questions concerning grading of meat were answered correctly by few consumers. Homemakers have the incorrect idea for example, that the U. S. Inspection Stamp and the U. S. Grade Stamp are probably the same thing. Sixty-five percent of the homemakers incorrectly agreed that beef that has been inspected and passed has also been graded by the U. S. Government.

Seasonal Trends

Homemakers knew little about seasonal trends. Only 30 percent of the homemakers knew that small eggs are usually cheaper per pound in September than large eggs and only 25 percent of the homemakers knew that the price spread between steak and chuck roast is usually wider in the summer months than the fall and winter months. Twenty-three percent answered both of the questions correctly concerning seasonal prices.

Non-fat Dry Milk

Non-fat dry milk has been impressed upon the consuming public as an economical means to get milk nutrients, but homemakers do not

understand very well its caloric or nutritional value. Only 19 percen knew that non-fat dry milk retains almost all its vitamins except Vita min A from the fluid whole milk.

Apples

Most homemakers knew that the Delicious variety of apples doe not make better pies than the MacIntosh variety. However, the Inde of Knowledge indicated about one-third of the homemakers were misinformed concerning the difference between the "U. S. No. 1" and "U. S. Fancy" grades.

Food Costs

The fewest homemakers correctly answered the questions con cerning food costs. In fact, more homemakers have a false conceptio of the relative costs of food and industrial wages and the cost of market ing and processing of foods than have the true facts. The Index o Knowledge was negative[3] for all three questions. The analysis indi cated that about as many guessed the right answer as the wrong answer in response to the statement relating marketing costs to in dustrial wages. About 45 percent more homemakers gave the incorrec response than the correct response to the statement, "The average American worker is spending about the same percentage of his income for food today as he did in 1940."

Relationship of Socio-Economic Factors and Homemakers' Level of Knowledge About Food Buying

Some of the most interesting relationships include the home makers' familiarity with the Consumer Marketing Information pro gram and their home economics training. A significant percentage o those homemakers who were familiar with the MIC program answered more questions correctly in every area of information than those who were not familiar with the program. Conversely, as shown in Table 2, none of the areas of information were significantly related to wheth er or not the homemakers had had any formal home economics edu cation.

The yearly income of the family and the amount the homemakers spent per week for food are also significantly related to the home-

[3]The negative Index of Knowledge indicates that a greater percentage of homemakers answered the statement incorrectly than answered it correctly.

TABLE 2—Areas of information related to socio-economic factors

Socio-economic factors	Eggs	Meat buying	Grades of beef	Marbling in beef	Non-fat dry milk	Apples	Food costs
Size of family	*	*	*	0	0	0	0
Income	*	*	*	*	*	*	*
Amount spent per week	*	*	*	*	*	*	*
Age	*	*	*	*	*	*	0
Education	*	0	*	*	0	*	*
Home economic education	0	0	0	0	0	0	0
Familiar with program	*	*	*	*	*	*	0
City	0	0	0	*	*	*	0

*Significantly related.
0 Not significantly related.

makers' knowledge in all six areas of information. With an increase in income and the amount spent per week for food, there was an increase in the percentage of homemakers who answered the statements correctly in all the areas except apples and food costs. The number of correct responses about apple grades were inversely related to these socio-economic factors.

The number of years of education of the homemakers was directly related to the egg buying, grades of beef and marbling in beef areas. The more education the homemakers had, the more statements they answered correctly. Here again, knowledge of apple grades was inversely related to years of education.

Those homemakers between the ages of 31 to 60 had the highest level of knowledge in most areas. In the meat buying, grades of beef and marbling in beef areas, the homemakers between the ages of 31 to 45 answered the most statements correctly.

The size of the family was directly related to only three areas. These were egg buying, meat buying, and grades of beef.

There was little difference, in general, in the level of knowledge of homemakers among the cities. Marbling in beef and apple grades were the only areas where the responses were found to be significantly different. Fewer homemakers in Flint answered the questions in these areas correctly than in the other three cities.

Awareness of MIC Program

A total of 29 percent of the homemakers in the four Michigan cities said they were familiar with the MIC program. Thirty-nine per-

cent agreed that such a food marketing program was helpful in foo buying.

It was found that those homemakers who were the most familia with the MIC program have families consisting of three or four o more, have yearly incomes of at least $4,000 and have had nine yea of education or more. A larger percentage of those who had som home economics training were also more familiar with the MIC pro gram than those who did not.

The homemakers expressed very little difference between th helpfulness to them of food marketing information giving food cos comparisons as compared with reports on future supplies and price It was found, though, that those who had the greater knowledge o expected future supplies and prices of foods were more likely to agre that this type of information would be useful.

Those homemakers who were familiar with the MIC program ha a positive attitude toward food marketing programs. These hom makers were more likely to agree that such a program was helpfu and the kinds of information on supplies and prices and cost compa isons were useful in their food buying. For example, a majority o homemakers (63 percent) thought that both kinds of information wer useful guides to food buying, but an even greater percentage (70 pe cent) of those homemakers who were familiar with the MIC progra thought that they would be useful.

If the homemakers were familiar with the MIC program, they wer also more likely to agree that such a program should be tax supporte Of those homemakers who said they were familiar with the MI Agents' program and articles, 71 percent thought a program to giv consumers information about food buying a proper activity of a ta supported institution. Only 51 percent of those who said they wer not familiar with the MIC program thought a food marketing progra ought to be tax supported. A total of 58 percent of all the hom makers thought a food marketing program should be tax supporte

SUMMARY

This study indicated that homemakers were not only generall uninformed but were frequently misinformed with respect to som areas of food buying and food marketing information. It also indicate a considerable difference in the level of knowledge in various areas o food buying and marketing information.

Homemakers were generally misinformed concerning food grades and standards. They also misinformed with respect to the costs of marketing food.

The level of knowledge about food buying was related to several socio-economic characteristics of the families. Generally homemakers under 30 years old and over 60, homemakers with less than 10 years of education and homemakers from smaller families and families with less than $4,000 income, scored lower in Level of Knowledge than the average of all homemakers.

While the Level of Knowledge was related to general education homemakers who had had home economics training did not show a higher Level of Knowledge.

Homemakers who were familiar with the MIC program had higher Level of Knowledge scores, on the average, than those who were not.

Homemakers who were familiar with the MIC program were much more inclined to agree that "a program to give consumers information about food buying is a proper activity of a tax supported educational institution."

This study indicated that a mail survey may be used to obtain useful information about consumers' knowledge of food buying. The check on the non-response bias for the mail survey indicated that it everestimates the level of knowledge but the bias is not so great as to significantly restrict the usefulness of the estimates for planning purposes.

QUESTIONS AND DISTRIBUTION OF RESPONSES FROM MAIL SURVEY

The following is a reproduction of the questions and instructions used in the Four-City survey.[4] The questions are in the order they appeared in the questionnaire. To the right of each question are the percentage distributions of responses from the 1,884 respondents to the mail survey.

Four-City Consumer Survey I

The following is a list of statements dealing with a number of things related to food and food buying. Would you please read each statement and then indicate with a √ whether you AGREE, DIS-

[4]The first four questions dealt with attitudes toward trading stamps and were used to increase interest in the questionnaire. These four questions are not included here.

AGREE, or have NO OPINION about the statement. You probably will not COMPLETELY agree or disagree with each statement, but we would like to know which ONE of the three choices comes CLOSEST to representing your opinion of each statement. If you feel you do not have an opinion about a statement, or that YOU DO NOT HAVE ENOUGH INFORMATION to form on opinion, please check the column headed "no opinion."

	Agree	Disagree	No opinion
	%	%	%
EGGS			
White eggs are better quality than brown eggs	11	77*	12
Eggs labeled "Fresh" must be graded and meet Grade A standards	64	23*	13
Small eggs are usually less expensive per pound than large eggs during September	46*	16	38
To meet the standards for Grade A eggs, they must be large and all white	18	66*	16
Grade B eggs are suitable for cooking	67*	12	21
MEAT BUYING			
The lower grades of beef do not have quite as much nutritional value as do the higher grades	15	75*	11
The larger the percentage of the center section of a whole pork loin that is included in a pork roast, the more desirable it will be	68*	11	21
A fresh Boston butt at 49c a pound will give you more lean pork per dollar than a fresh picnic shoulder at 39c a pound	41*	20	39
The amount of edible meat per pound is usually greater for a butt portion than for the butt half of ham of equal quality	20	25*	55
Most people would find that ham labeled "Ready-to-eat" is cooked enough to eat without further cooking	35	58*	7
The fat around the edge of beef is known as the marbling	19	43*	38
There is usually more difference in price between chuck roast and steak in the summer than in the fall and winter months	40*	15	45
A higher Grade is more important when choosing steak than when choosing chuck roast	70*	19	11

*Indicates correct response.

	Agree	Disagree	opinion
	%	%	%
ECONSTITUTED NON-FAT DRY MILK (Powdered milk mixed with water according to directions)			
does not taste as good as fresh skim milk	55	19	26
has only about half the number of calories per glass as fluid whole milk	50*	14	36
costs about ⅓ as much as fluid whole milk	64*	5	31
has all the vitamins and minerals that are in fluid whole milk except Vitamin A	34*	14	52
GRADES OF BEEF			
.S. Grades for beef are of little value—the only way to tell the quality of meat is to look at it	14	75	11
he higher the Grade of beef the less fat it will have.	20	68*	12
eat graded U.S. Good is a higher Grade than U.S. Commercial	52*	8	40
eat graded U.S. Choice is a higher Grade than U.S. Prime	16	53*	31
l meat stamped "U.S. Inspected and Passed" has been graded by the U.S. Government	65	13*	22
ou can usually expect more marbling in a higher Grade of beef	54*	15	31
APPLES			
he Delicious variety of apple makes better pies than the MacIntosh variety	7	80*	13
ichigan's grading laws give you reliable guides to the quality of fruits and vegetables	60	10	30
ccording to Michigan law, all Michigan apples must be identified by grade when sold	45*	14	41
he only difference between "U.S. 1" and "U.S. Fancy" is the color of apple	12*	43	45
FOOD COSTS			
he average American worker is spending about the same percentage of his income for food today as he did in 1940	19*	64	17
costs twice as much today to process and market food as the farmer gets for growing it	45	13*	42
would take the average American worker more time today than it did in 1940 to earn the money needed to buy the same food he bought in 1940	40	38*	22
FOOD MARKETING—GENERAL			
od cost comparisons such as the relative cost per serving of fresh, canned and frozen foods would be useful guides to your food buying	70	8	22
eports about expected future supplies and prices of food would be useful guides to your food buying.	75	8	17

	Agree	Disagree	No opinion
FOOD MARKETING—GENERAL (continued)	%	%	%
A program to give consumers information about food buying is a proper activity of a tax supported educational institution	56	8	36
The food-buying tips given by Alice Boyts over your local radio station are helpful in planning weekly food purchases	25	5	70
The information supplied by local consumer marketing information agents such as Harriet Lundberg, Mary Ann Meldrum, Virginia Helt, or Catherine Love through radio and T.V. programs and newspaper articles is helpful in planning food buying	39	4	57
	Yes	No	
Are you familiar with the programs or articles of any of these consumer agents	% 29	% 71	

*Indicates correct response.

Now we would like to know a little about you and your family.

How many persons are there in your household? That is, how many eat their meals regularly in your home?

One	6%
Two	27%
Three or four	40%
Five or more	24%
Returned blank	3%

About what was the total income of all members of your household from all sources after federal income taxes were deducted in 1956? Please check the category which best fits your estimate.

Less than $4,000	21%
$4,000 - $6,000	40%
Over $6,000	24%
Prefer not to say	15%

About how much did your household spend for food per week during the last year.

$10.00 or less	5%
$10.01 - $20.00	28%
$20.01 - $30.00	41%
Over $30.00	17%
Don't know	9%

About how old are you?

30 or less	20%
31 - 45	36%
46 - 60	27%
Over 60	15%
Returned blank	2%

About how many years of formal education have you completed?

0 - 8	12%
9 - 11	15%
12 - 13	37%
14 or more	30%
Returned blank	6%

Did you take any home economics courses in high school or college?

Yes	41%
No	53%
Returned blank	6%

RELATIONSHIP OF LEVEL OF INSTALLMENT PAYMENTS TO FAMILY CHARACTERISTICS AND APPROACH TO THE FOOD BUDGET[1]

By DAVID SPAETH and JAMES D. SHAFFER

Department of Agricultural Economics

WHAT PROPORTION OF FAMILIES are committed to make monthl payments on their home, car or appliances? How much of thei monthly income is committed to regular monthly payments? Wha types of families are most highly committed to monthly payments How are the types of payment commitments and the level of com mitment related to the family's approach to the food budget?

Information related to these questions was obtained as part of personal interview survey of 1,200 Lansing, Michigan, families mad during the late spring of 1958.[2] The sample was selected by takin every 5th address from every 5th street as listed in the address sectio of the Lansing City Directory.[3]

The respondents were asked, "Do you have any monthly payment of the following type?" Their responses were as follows:

18 percent paid rent
46 percent had house payments
29 percent made installment payments on cars
26 percent had installment payments on appliances and on th home furnishings
94 percent had utility payments, and
84 percent reported monthly insurance payments.

This question was followed by one which attempted to establis an estimate of their level of monthly commitment for these six type

[1]The authors are indebted to Lester Mandersheid, Gerald Quackenbush and Vernon Sorens for their helpful suggestions and criticisms.

[2]This survey dealt with a number of related questions including impulse purchases and reacti to several hypothetical food-buying situations. The questionnaire also included questions abo unemployment and beliefs about the influence of newspaper advertising of food. The survey w part of a broader study of consumer decisions in food buying.

[3]Published by R. L. Polk & Co., 1955.

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of payments. The question was, "Now I wonder if you could give an estimate of the percentage of your current income (after Federal income taxes) which is committed to these payments?" The average estimate of those reporting was slightly more than 36 percent.[4] Since this figure is an estimate and not drawn from family records it should be viewed as being only sufficiently accurate to identify the family with a level of commitment group. This is the manner in which the information was used.

Type of Payments and Income Level

Table 1 shows the percent of families in each income group who reported payments on rent, house, car, appliance and some combination of these four. Insurance and utility payments were considered to be sufficiently universal as to approach a constant for purposes of this paper.

TABLE 1—Percent of families in designated income groups making different kinds of monthly payments

Kind of payment	Percent of total sample	2,000 and under	2,001-4,000	4,001-5,400	5,401-7,000	7,001-10,000	10,001 and over
		Percent of families(*b*)					
Rent	18	27	29	20	15	9	6
House payments	46	15	32	52	59	56	52
Car payments	29	7	20	37	34	38	7
Payments on appliances(*a*)	26	15	35	32	27	21	8
Pay neither rent nor house payments	38	59	40	29	28	36	45
No payments except insurance or util.	29	52	31	20	18	28	44
Rent or house payments and car payments(*a*)	24	4	17	31	29	32	14
Rent or house payments and appliance payments(*a*)	21	10	17	28	22	18	8
Rent or house payments plus car and appliance payments(*a*)	10	4	8	15	14	9	0

(*a*) Appliance payments includes payments on household furnishings in addition to electrical appliances.
(*b*) The percentages were computed vertically. The percentages do not add up to 100% since the categories of "kind of payments" overlap (e. g. those paying rent reappear in four of the subsequent eight "type-of-payment" groups).

The lowest income group had a higher percent of families who had none of these four kinds of payments relative to other groups, and among those in this group who make payments, rent was the most important type of payment. Only 20 percent of this group had

[4] Although 1200 families were interviewed not all families were able to answer all of the questions. This accounts for the variation in the number of families shown in the tabulations. Only two-thirds of the families gave adequate estimates of the percent of their incomes committed to the six types of payments.

either car payments or payments on appliances. The low income group was made up largely of older people, the majority of whom were retired. The fact that their income is not committed to payments of this type means that a much larger percentage of their current income is available for food and other current necessities.

The group with incomes over $10,000 included 44 percent who had none of the four listed types of payments. Almost all of those in the upper income group who had payments were making payments on a house. Very few were renters and less than 16 percent were making installment payments on cars or appliances.

The middle income groups—between $4,000 and $7,000—had the largest percentage of families with monthly commitments. Over 80 percent of them had at least one of these four types of payments and about 15 percent had rent or house payments and installment payments on both appliances and car. It may be inferred that institutional credit restrictions may lead to withholding credit from the lower income groups.

Type of Payments and Level of Commitment

Table 2 shows the percent of families at each level of monthly commitment who had particular types of payments to meet. Thirty percent of those families who had committed 60 percent or more of their income had rent or house payments and both car and appliance payments. Of those who had less than 20 percent of their income

TABLE 2—Percent of families at designated monthly payment levels who made payments of different types

Kind of payment	Percent of income committed				
	0-19	20-29	30-39	40-59	60
	Percent of families(*b*)				
Rent	4	15	22	26	35
House payments	21	53	64	60	57
Car payments	10	20	54	29	56
Appliance payments(*a*)	5	17	51	24	55
Pay neither rent nor house payments	74	33	15	16	11
None of these four types of payments	65	21	9	7	4
Rent or house payments plus car payments	5	14	30	39	52
Rent or house payments plus appliance payments(*a*)	3	9	24	37	49
Rent or house payments plus car plus appliance payments(*a*)	1	2	10	17	30
Number of families	185	160	138	164	157

(*a*) Appliance payments include household furnishings in addition to electrical appliances.
(*b*) Percentage was computed vertically (e.g. 4 percent of those who are committed at the 0-19% level payment).

committed, 74 percent paid neither rent nor had house payments, and 65 percent had neither rent, house payments, car payments nor appliance payments.

Level of Monthly Payments and Family Characteristics

Table 3 relates the level of commitment to various family characteristics for the 800 families who were able to estimate the percent of their incomes committed to the six types of payments.

Type of Payments.—Table 3a shows the percent of families with different types of payments who fell in each of the commitment level groups. It shows, for example, that 35 percent of the families who pay rent have committed 60 percent or more of their income while only 22 percent of those with house payments are this heavily committed. Less than half of those with house payments had committed as much as 40 percent of their income to monthly payments. Half of the families with rent or house payments and both car and appliance payments had committed more than 60 percent of their incomes.

Family Income—(Table 3b) There was a statistically significant relationship between income and the percent of income committed to monthly payments.[5] Sixty-three percent of those earning $10,000 or more were committing less than 20 percent of income to monthly payments, while about a fourth of those in each category of income less than $5,400 were paying 60 percent of their incomes or more, as

[5]Significance, where stated, is at the .1 percent level.

TABLE 3—Percent of families with various income, payment and family characteristics who are committed to monthly payments at designated percent of income levels

Kind of payments	Number of families	Percent of income					
		0-19	20-29	30-39	40-59	60+	Total
		Percent of families					
3a							
Rent	160	4	15	19	27	35	100
House payments	399	10	21	22	25	22	100
Car payments	260	7	12	28	18	35	100
Appliance(a) payments	233	4	12	30	17	37	100
Pay neither house payments nor rent	253	54	21	8	10	7	100
No payments except insurance and utilities	185	66	18	7	6	3	100
Rent or house payments plus car payments	219	4	10	19	29	38	100
Rent or house payments plus appliance payments	192	3	8	17	32	40	100
Rent or house payments plus car and appliance payments	94	2	3	15	30	50	100

TABLE 3—Concluded

Kind of payments	Number of families	Percent of income					
		0-19	20-29	30-39	40-59	60+	Total
		Percent of families					
3b							
Income**							
$2,000 or less	82	23	21	10	22	24	100
$2,001-$4,000	131	23	15	15	23	24	100
$4,001-$5,400	236	15	15	24	19	27	100
$5,401-$7,000	196	16	21	18	29	16	100
$7,001-$10,000	150	32	28	17	12	11	100
$10,000 or more	41	63	17	10	10	0	100
3c							
Occupation**							
Factory worker	179	23	23	14	17	23	100
Labor not factory or construction	47	19	19	11	23	28	100
Clerical, sales clerk	89	15	16	17	31	21	100
High level salesman or business man	75	32	20	20	19	9	100
Professional	103	30	21	20	16	13	100
Other white collar workers	44	14	29	27	16	14	100
Other blue collar workers	165	15	16	19	24	26	100
No workers	87	38	18	15	16	13	100
3d							
Age of male head**							
Under 30	129	8	10	23	26	33	100
31-40	195	10	23	17	27	23	100
41-60	278	30	22	17	17	14	100
Over 60	84	50	19	12	15	4	100
3e							
Age of female head**							
Under 30	169	7	13	21	26	33	100
31-40	215	10	24	16	27	23	100
41-60	285	35	20	18	15	12	100
Over 60	118	36	24	14	13	13	100
3f							
Composition of family**							
No children—wife 40 or under	41	10	10	14	32	34	100
Children under 10	231	10	15	23	24	28	100
Children 10-19	124	28	18	19	20	15	100
Children under 10 and 10-19	118	12	24	12	27	25	100
No children—wife over 40	261	41	25	14	12	8	100
3g							
Number in household**							
1	65	32	18	19	11	20	100
2	205	34	25	12	16	13	100
3 or 4	318	22	18	20	23	17	100
5 or more	208	11	17	17	25	30	100

(*a*) Appliances include household furnishings in addition to electrical appliances.

**Significantly different at .1 percent level based upon a Chi square test applied to the numerical distributions.

monthly payments. Nearly a fourth of the families with incomes under $4,000 per year paid less than 20 percent on the four major types of payments. These were undoubtedly older people living on retirement incomes.

Occupation—(Table 3c) There was a statistically significant relationship between occupation and the level of monthly payments. As might be suspected from the usual incomes for each group, low commitments were characteristic of businessmen, high-level salesmen, and professionals. The retired group reappears with 38 percent of families with no workers in the group committing less than 20 percent of income. High commitment levels were associated with factory workers, other blue collar employees, clerical and construction workers.

Age—(Tables 3 d and e) There was a statistically significant relationship between the age of male or female head of the household and the level of commitment. Low levels of commitment were associated with family heads over 40 years of age. High levels of income commitment were associated with ages of under 40.

Type of Family—(Table 3f) There was a statistically significant relationship between family composition and the level of income committed to monthly payments. The lowest levels of commitment were evident where there were no children and the wife was over 40, and households without children under 10. The higher levels of commitment occurred in categories of: families with no children and the wife under 40; those with children 10 years old or younger.

Size of Family—(Table 3g) A statistically significant relationship existed between size of a family and commitment level. Families with 2 members or less generally had the lowest commitment level. Commitment of 60 percent or more of income to monthly payments was more frequent among families of 5 or more.

Commitment Level and Approach to Food Budget

A statistically significant relationship existed between the percent of income committed and a stated approach to the food budget as shown by Table 4.

In Table 4a it will be noted that a majority stated that they bought about what they wanted but just weren't extravagant. The majority

of this sub-group had commitments of less than 40 percent. Of the 37 stating that the food budget is determined as a residual, 62 percent were committed at the 60 percent level. Of those stating that the cost of food was of no concern, 50 percent had commitments of less than 20 percent of income for the 4 major types of payment.

As table 4b indicates, the wife was the principal decision maker in determining the size of the food budget. However, 32 percent of the families where the husband decided the size of food bill were committed at 60 percent or more. Where the decision-maker was someone other than the husband or wife, the commitments tended to be low.

The amount of money available as a determinant of the size of the food bill was important for families committed at 40 percent level or over. Kinds and quantities of food desired, as a determining factor, is important where commitments are under 40 percent. These tabulations are shown in Table 4c.

Table 5 shows the relationship between types of payments, and the general family approach to the food budget. Fifty-five families

TABLE 4—Relationship between percent of income committed to monthly payments and the approach to the food budget

Committed percent of income	Number of families	0-19	20-29	30-39	40-59	60+	Total percent
4a							
General approach to food budget***							
1. Food budget is a residual	37	3	13	11	11	62	100
2. More or less fixed budget	105	19	14	14	24	29	100
3. General idea of a maximum	212	13	18	18	28	23	100
4. Buy what is wanted but not extravagant	402	29	23	19	17	12	100
5. Cost of food no concern	42	50	26	7	14	3	100
4b							
Who decides what is spent for food**							
Husband	78	19	17	5	27	32	100
Wife	361	23	19	19	23	16	100
Both	237	22	23	18	18	19	100
Other person	124	29	17	16	15	23	100
4c							
Which is more important indetermining size of food bill***							
Amount of money		12	17	16	26	30	
Kinds and quantity of food desired		31	22	18	16	13	
Number of families		185	160	138	164	157	

**Significantly different at 1 percent level based upon Chi square test applied to numerical distributions.
***Significantly different at .1 percent level based upon Chi square test applied to numerical distributions.

TABLE 5—Percent of families with specified approaches to the food budget who are committed to various types of monthly payments

Group(a) Kind of payment	Total sample	(a) Food is residual	(b) Fixed budget	(c) General maximum	(d) Just not extravagant	(e) Cost no concern
	Percent of families					
Rent	18	42	24	23	14	6
House payments	46	35	59	50	44	30
Car payments	29	33	38	30	27	20
Payments on appliances(f)	26	56	27	37	18	11
Pay neither rent nor house payments.	38	25	18	28	43	64
No payments except in insurance and utilities	29	18	12	19	36	53
Rent or house payments plus car payments	32	32	34	25	23	12
Rent or house payments plus appliance payments(f)	21	43	26	32	13	6
Rent or house payments plus car plus appliance payments(f)	10	25	13	11	8	4
Number of families	1200	55	141	305	601	79

(a) Food budget is what is left over after paying necessary bills.
(b) We have a more or less fixed food budget.
(c) We have no fixed budget but have in mind a general maximum.
(d) We buy about what we want, but are not extravagant.
(e) We buy just what we want, cost is no problem or concern.
(f) Appliance payments includes payments on household furnishings in addition to electrical appliances.

stated that the amount of money spent for food was a residual after payment of necessary bills.

Among these 55 families, the salient types of payment were rent, appliance payments, and a combination of rent or house and appliance payments. Sixty-four percent of the 79 families who stated that the cost of food was no concern were paying neither rent nor house payments, and 53 percent of this group is making no payments. Among the largest group (601) who stated they were just not extravagant, 44 percent were making house payments, 43 percent no payments for rent or house, and 36 percent no payments of the four major types. The category where the cost of food is no concern was the only one in which a majority of families were making neither rent nor house payments.

Table 6 also relates the type of payment with approach to the food budget, but describes the type of payment. The most severe restrictions on the food budget are found among those paying rent and/or appliance payments. Where there is no payment for house or rent a minimal restriction on the food budget is evident. House and car payments seem to cause an equal increment in restrictions of

TABLE 6—Percent of families with various types of payments with different approaches to the food budget

Kind of payment	Total group	(a) Food is residual	(b) Fixed budget	(c) General maximum	(d) Just not extravagant	(e) Cost no concern	Total percent	No. of families
	Percent of families							
Rent	18	11	16	33	38	2	100	215
House payments	46	3	15	28	50	4	100	547
Car payments	29	5	16	27	47	5	100	340
Payments on appliances(*f*)	26	10	13	37	37	3	100	303
Pay neither rent nor house payments	38	3	6	19	60	12	100	433
No payments except insurance and utilities	29	3	5	17	63	12	100	341
Rent or house payments plus car payments	32	6	16	27	48	3	100	287
Rent or house payments plus appliance payments(*f*)	21	10	15	40	33	2	100	245
Rent or house payments plus car plus appliance payments(*f*)	10	12	16	30	39	3	100	115

(a) Food budget is what is left over after paying necessary bills.
(b) We have a more or less fixed food budget.
(c) We have no fixed budget but have in mind a general maximum.
(d) We buy about what we want, but are not extravagant.
(e) We buy just what we want, cost is no problem or concern.
(f) Appliance payments includes payments on household furnishings in addition to electrical appliances.

food budget. The combination of house payments or rent plus car payments adds little further restriction.

There was no significant relationship between level of payments and education of male head of the household, whether or not canning and gardening was done, or who in the family was earning $800 per year or more.

SUMMARY

In this sample of Lansing families, the level of commitment of income to monthly payments was found to be related to the approach to the food budget, income, occupation, age of family head, composition of family (children or no children, etc.) and the size of the household. There was little or no statistically significant relationship to education of male head, whether or not canning and gardening was done, or who was the family wage earner.

Of the 1200 families 71 percent were making payments on housing, car, or appliances. The largest single category of payments was payment in the purchase of a home, which was the dominant payment except at incomes of less than $4,000. The smallest single category was appliance payments. Ten percent of the families were committed to payments for housing (either rent or house payments), plus both car and appliances on a monthly basis.

The level of income committed ranged widely. In general, low percentages of monthly commitments were associated with the older heads of households, higher incomes, and households with no workers (retired). High monthly commitments were associated with incomes under $5,400, young family heads, households of five or more, and those with young children.

The approach to the food budget was related to commitment levels. Families with high commitment levels and rent and appliance payments tended to approach the food budget with considerably more restraint than those with fewer commitments. Where the size of the food budget was claimed to be of no concern, the family tended to be free of housing payments or all payments except utilities and insurance. Seventy-six percent of those who said the cost of food was of no concern were committed at less than 40 percent of their income, and were in the higher income groups.

In general, it may be inferred that there is some sort of minimal complement of assets deemed necessary in the household and where

institutional credit regulation will allow (usually on the basis of income) these items will be brought up to high levels of income commitment. Home ownership seems highly sought and was the most universal type of payment.

Middle income families are able to secure credit and in the years when the family is growing they frequently commit a high proportion of their income to fixed payments. This appears to put pressure on the food budget and influences their approach to food buying. In general it appeared that the approach to the food budget was influenced only by fairly high levels of commitment.

ESTIMATED COSTS OF RETAILING FROZEN MEATS AS COMPARED TO FRESH MEATS

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INTRODUCTION

IN RECENT YEARS there has been increasing interest in the possibilities of processing and distributing frozen meats. A complete change-over from our present system of handling fresh meats would undoubtedly require substantial adjustments throughout the meat industry. Whether such a change will occur on a broad scale still remains to be seen. If it does occur, it seems likely that nearly all of the meat cutting and packaging now done in retail stores will be transferred to packing houses or centralized processing plants.

The purpose of this study was to estimate the effect of a change-over to frozen meats on the costs of operating meat departments in modern retail food stores. This study does not attempt to estimate the extent to which potential reductions in retailing costs may be offset by increased costs at other places in the marketing system.

The information developed in this study should be helpful to retailers who are contemplating the construction of new stores or the remodeling of existing facilities. Store layout and the investment in equipment would likely be affected by a shift toward frozen meats. Meat processors and equipment manufacturers may be interested in possible changes in retailing as it affects their businesses.

Trends in Meat Retailing

Over the past 50 years there have been substantial changes in meat retailing. These changes have been gradual and have been associated with more general trends in food distribution. One of the most noticeable changes of a general nature has been the emergence of the modern supermarket as the dominant retail food outlet.

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This has been accompanied by a change-over toward self-service selling of prepackaged foods. The packaging of grocery items has shifted almost entirely from the retail store to centralized processing plants. More recently certain produce items and processed meat products are being packaged into consumer-sized units at processing plants or central warehouses. The general trend has been for food processing and packaging operations to be shifted from retail outlets to centralized plant operations.

Despite these changes in food marketing, most fresh red meats are fabricated and packaged into consumer-sized units within the retail store where it is sold. Although centralized prepackaging of fresh meats has been tried it has not been widely adopted. Some of the difficulties with centralized fresh meat processing center around the problem of maintaining "freshness".

If the fabrication and packaging of fresh meats is to be shifted from the retail store, some method such as freezing or irradiation will be necessary in order to make these items less perishable. At the present time, the procedures for irradiation of meat products are still in the process of development and have not been approved for commercial use. Many problems of flavor and appearance remain to be solved.

The extent to which frozen meats will be adopted is still uncertain. Several trades people have been expecting significant shifts toward frozen meats. However, the recent attempts of some of the large meat packers to introduce complete lines of frozen red meats has tempered some of the earlier optimism.

Some of the economic aspects of shifting toward a system of frozen meat distribution are discussed in a recent study made by the U. S. Department of Agriculture. (9) This study was an attempt to explore in somewhat more detail the effects on the retailing operation should there be a major change-over to frozen meats.

Procedures for Comparing Costs

The volume of frozen meats being retailed is still too small to make possible cost comparisons between stores selling frozen meats as compared with similar stores selling fresh meat. However, it was possible to assemble reasonable estimates of meat retailing costs for present methods of operations. These estimates were based largely on data published from a survey of retail food stores in the North

Central States. (8) Additional information was taken from a study made by Wiegman, et al., at Iowa State College where costs in self-service meat markets were compared with costs in service markets for stores with different sales volumes. (10)

Estimates of costs for retailing frozen meats were based in part on data from a study of the handling of frozen foods in retail stores and on consultation with store equipment representatives. In order to simplify this problem, certain **assumptions** were made. These should not be construed to be predictions but as useful restrictions within which to make cost estimates. The assumptions were as follows:

(1) That frozen meat cuts will be packaged in rectangular cardboard containers with net weight printed on the carton.

(2) That consumers will eventually accept frozen red meats at prices not greatly different from present price relationships after allowance for bone and fat trim.

(3) That stores could shift their operations so that all meats now processed and sold as fresh cuts would be sold as frozen cuts.

(4) That all other meat department items such as luncheon and cured meats would be prepackaged before arrival at the retail store.

Comparisons were developed for the major cost items in meat department operations. Four items, labor, equipment, space, and wrapping supplies account for approximately 80 percent of total meat retailing costs. (4)

The retailing costs per pound of meat vary considerably between stores of different sizes. Therefore, estimates were developed for three size categories (Table 1).

The small stores had average weekly sales of 716 pounds of meat

TABLE 1—Average weekly meat sales for stores grouped by size, North Central states, 1953(a)

Size group	Weekly meat sales dollars	Average weekly meat sales pounds
SMALL.....	Less than $999.....	716
MEDIUM.....	$1,000-$4,999.....	3,081
LARGE.....	Over $5,000.....	13,020

(a) Source: Retailing Meats in the North Central States, Sta. Bul. 622, Agr. Expt. Sta., Purdue Univ., Lafayette, Ind. 1955, pp. 6, 14.

while the medium stores averaged 3,081 pounds per week. Although the large stores had average weekly meat sales of 13,020 pounds this is somewhat below the sales volume of many of the largest supermarkets operating in 1958.

Labor Costs

Use of Labor in Meat Departments

Labor is the most costly input used in the meat retailing operation. Total labor costs usually account for 50 to 70 percent of meat retailing costs. (4 and 6)

Under the present methods of meat merchandising, skilled labor is required to convert wholesale meat cuts into retail packages. In a time study conducted in a large self-service market it was found that two-thirds of the total market time in retailing meats was used for cutting and packaging activities. (6) If all meat preparation was shifted from the retail store a substantial reduction in labor costs would be expected. A rough estimate of the potential saving in labor can be made by comparing total labor requirements under present methods of retailing with expected requirements when most of the meat is handled as a frozen product.

Labor Requirements in Retailing Fresh Meats

Pounds of meat handled per man hour of labor tends to vary directly with store volume. In a study of meat retailing in the North Central states it was found that meat sales ranged from 12 pounds per man hour in the smallest stores to 48 pounds per man hour in markets with largest volumes.

Data from both service and self-service markets were averaged together in computing measures of productivity. This seems reasonable since Wiegmann's (10) and Kramer's (11) comparisons of costs between service and self-service meat departments indicate relatively small differences in hourly labor requirements between the two types of operations. Labor costs per dollar of sales tend to be slightly lower in the self-service markets since it has been possible to use lower cost labor in the packaging operation than is normally used in a service operation.

For this study the labor requirements reported in the North Central states' study (8) were used. For the small stores an average of

17 pounds of meat products were handled per man hour. This compares with an average of 30 pounds per man hour in the medium stores and 42 pounds in the large stores.

Labor Requirements in Retailing Frozen Meats

Estimates of labor requirements in retailing frozen meats were derived by adjusting data on the handling of frozen foods in retail stores. In a 3-store study by Anderson and Shaffer (2), it was found that an average of 4.626 man minutes was required to handle one case of frozen food using conventional methods.

By adopting improved methods and equipment this was reduced to an average of 3.378 man minutes per case. These time requirements cover the following operations: receiving, placing in freezer, removing from freezer, price marking, backroom operations, display, policing cases, travel time, disposal of empty cartons, taking inventory, keeping records, and an allowance for personal and fatigue time.

Assuming that frozen meats will be packaged in rectangular consumer-sized units and delivered to retail stores in paper-board cases, the above labor requirements were adjusted upward to approximate anticipated labor needs.

It was recognized that cases of frozen prepackaged meats are heavier than the average case of frozen food. For this reason time requirements for handling frozen meats were estimated to be 20 percent greater than for frozen foods. Another upward adjustment was considered necessary to account for the additional time required to price mark odd-weight packages of meat. It was estimated that approximately one-half of the meat packages would be odd-weight. The time required for pricing these packages should be comparable to that of operating a label printing machine such as now used in many self-service meat markets.

Harwell, et al. (6) report that it required .189 man minutes to position a meat package on the scale, ring up, attach label, and dispose of the package. Since most packages of frozen meats show the net weight when received, a pricing book would replace the weighing operation. Assuming that there are 18 packages of frozen meat per carton, the time required to price each case of odd-weight packages would be 3.4 man minutes. After making the adjustment for the additional weight of meat packages and time required to price mark odd-weight packages, it would require an average of 6.845 man

minutes to handle a carton of prepackaged meat products using conventional methods of operation.

Based on improved methods for handling frozen foods (3) it would require 5.6 man minutes per carton of meat. Using an estimated average weight per case of 25 pounds, meat handled per man hour would range between 219 and 266 pounds where all items are received prepackaged.

Reduction in Labor Requirements

The estimates derived above indicate that even with the lower estimate of 219 pounds per man hour for handling frozen meats, this would represent a potential reduction of 80 to 93 percent over the time required under present methods of merchandising meats in small, and large retail outlets (Table 2).

TABLE 2—Estimated weekly labor requirements for retail handling fresh and frozen meats

Store size	Total meat handled pounds	Total man hours		Percent saving
		Fresh meat	Frozen meat	
SMALL.....	716	42(*a*)	3(*d*)	93
MEDIUM.....	3,081	102(*b*)	14(*d*)	86
LARGE.....	13,020	309(*c*)	60(*d*)	80

(*a*) Based on 17 pounds per man hour.
(*b*) Based on 30 pounds per man hour.
(*c*) Based on 42 pounds per man hour.
(*d*) Based on 219 pounds per man hour.

Even though 25 percent of the meats would continue to be non-frozen luncheon and cured meat items it is anticipated that these would be purchased from wholesalers as prepackaged items which could be delivered directly to the display case in the small stores.

Equipment Costs

Meat Equipment Used

Costs associated with meat department equipment account for about 7 percent of all meat retailing costs. Most retail food stores use approximately the same items of equipment in meat departments. (8) Meat department equipment may be divided into three distinct types: (a) display cases, (b) storage facilities, and (c) preparation equipment. In one study, display equipment accounted for 62

percent of total investment in meat department equipment for self-service meat departments, storage facilities (coolers) accounted for 22 percent and preparation equipment for 16 percent. (10)

Display Case Needs and Costs

In the average small store in the North Central states, refrigerated case needs amount to 13 linear feet when all meats are sold self-service as freshly packaged red meats, fish, poultry, luncheon meats, bacon, sausage, etc. (8) Case requirements under similar conditions for the average medium store were 26 linear feet, and for the average large store, 65 linear feet. This space is used for an average weekly meat sale of 716 pounds in the average small store, 3,081 pounds in the average medium store, and 13,020 pounds in the average large store (Table 3).

Allowing for luncheon meats, bacon and some sausage which makes up about 25 percent of all meats (12), and assuming that the same tonnage of frozen meats would be sold as are being sold as freshly-packaged meats, the average small store would sell 537 pounds of frozen meats, the average medium store would sell 2,311 pounds, and the average large store would sell 9,765 pounds (Table 4).

Frozen meat cases have greater cubic capacity per linear foot than normal temperature cases. It is possible, therefore, that a shift to frozen meats could reduce the actual linear feet of display cases. But since good merchandising practices dictate the use of sufficient space for displaying plainly a wide variety of frozen meat packages, the needs for display cases on a linear foot basis likely would not be greatly different from needs for freshly-packaged meats.

Due to the differences in cubic capacity per linear foot in normal

TABLE 3—Linear feet of display equipment needed for selling meats in the North Central states in 1953

Store size	Average pounds of meats handled per week (lbs.)	Fresh meats handled per linear-foot of display case (lbs.)	Linear feet of display case needed for fresh meats (ft.)
SMALL	716	54	13.3
MEDIUM	3,081	117	26.3
LARGE	13,020	201	64.8

Source: Retailing Meats in the North Central States, Sta. Bul 622, Agr. Expt. Sta., Purdue Univ., Lafayette, Ind. 1955, pp. 6, 14.

TABLE 4—Amount of frozen meats and non-frozen meats(a) that would be sold in retail stores shifting to frozen meats

Store size	Total meats handled (lbs.)	Frozen meats handled (lbs.)	Non-frozen(a) meats handled (lbs.)
SMALL.....	716	537	179
MEDIUM.....	3,081	2,311	770
LARGE.....	13,020	9,765	3,255

(a) Non-frozen meats refer to luncheon meats, bacon, sausage, etc., which account for about 25% of all meats handled.
Source: Table 3 and calculations explained in text.

temperature cases and frozen meat cases, perhaps a sufficient reduction could be made in the linear footage to offset the somewhat higher costs of frozen meat cases on a per linear foot basis. On balance, case costs likely would neither be increased nor decreased due to shifts to frozen meats.

Storage Facility Needs and Costs

The average small store in the North Central states has about 59 square feet in cooler space. The average medium store has about 108 square feet, and the average large store, about 241 square feet devoted to meat coolers. (8)

Assuming that space allocation would be made to the various types of meats sold on the basis of sales proportions, about 15 square feet of cooler space would be needed in the average small store for the 25 percent of total sales represented by luncheon meats, bacon, sausage, etc. This leaves about 44 square feet of cooler space for freshly-packaged red meats, poultry, and fish. In the average medium store, about 27 square feet would be devoted to the luncheon meats, bacon, and sausage and about 81 square feet to freshly-packaged red meats. In the average large store, the division would be about 60 square feet for the luncheon meat, bacon, and sausage group and about 181 square feet for freshly packaged meats (Table 5).

Estimates by frozen meat packers as to a reasonable ratio of weight to cubic volume of frozen meats suggests that an allowance of one cubic foot of storage space for about 40 pounds of frozen meats would be sufficient. Therefore, a frozen meat storage cabinet containing about 13 cubic feet of space would be sufficient for the 537 pounds of meats which the average small store would handle even

TABLE 5—Meat cooler space used in retail food stores in the North Central states and the space allotment to various kinds of meats

Store size	Total meats handled (lbs.)	Total cooler space (sq. ft.)	Space for fresh meats (sq. ft.)	Space for non-red meats(*a*) (sq. ft.)
SMALL	716	59	44	15
MEDIUM	3,081	108	81	27
LARGE	13,020	241	181	60

(*a*) Non-red meats refer to the approximately 25 percent of total meats made up of luncheon meats, bacon, sausage, etc.
Source: Retailing Meats in the North Central States, Sta. Bul. 622, Agr. Expt. Sta., Purdue, Univ., Lafayette, Ind., 1955, pp. 6, 14.

if it had only once-a-week delivery. By the same calculations, and including a 25 percent allowance for working space, the average medium store would need about 73 cubic feet of storage space for frozen meats, and the average large store would need about 305 cubic feet of frozen meat storage space (Table 6).

Assuming that the 44 square feet of normal temperature storage cooler in the average small store represented a storage capacity of 352 cubic feet (44 square feet x 8 feet high), a difference of about 339 cubic feet of storage space would be saved by shifting to frozen meats. (Calculated storage needs for frozen meats in the average small-size store was 13 cubic feet. Thus, 352 — 13 = 339).

By the same methods of calculation it may be established that the space savings for the average medium store that shifts to frozen meats could be the difference in 648 cubic feet (81 square feet x 8 feet high) used in a freshly-packaged meat operation and the 73 cubic feet needed for frozen meats or 575 cubic feet. Also, space

TABLE 6—Storage space savings resulting from a shift to frozen meats

Store size	Total meats handled (lbs.)	Space needs for fresh meats(*a*) (cu. ft.)	Space needs for frozen meats (cu. ft.)	Space savings (cu. ft.)
SMALL	537	352	13	339
MEDIUM	2,311	648	73(*b*)	575
LARGE	9,765	1,448	305(*b*)	1,143

(*a*) Cooler floor space needs (from Table 5) times 8 feet high.
(*b*) Allowance of 25 percent for working space has been made.
Source: Table 4 and calculations explained in text.

savings in the average large store would be the difference in the 1448 cubic feet (181 square feet x 8 feet high) needed in the freshly-packaged operation and the 305 cubic feet needed for frozen meat storage, or 1143 cubic feet (Table 6).

Based on estimates by meat cooler and frozen food cabinet dealers, it is assumed that frozen meat storage installations cost about 20 percent more per cubic foot of space than do normal temperature (34-36° F.) meat coolers. After making allowance for this difference, a saving of approximately 95 percent of the cost for storage space could result from a shift to frozen meats for the average small-size store, 86 percent for the average medium-size store, and 75 percent for the average large-size store.

Preparation Equipment Needs and Costs

There would be little need for preparation equipment in a store selling only meats that have been prepackaged before arriving at the store. Equipment could be limited to a scales for checking weights, price marking equipment and a hand iron for sealing damaged packages. It is estimated that the overall saving in preparation equipment costs would be about 95 percent with a complete shift to frozen meats.

Summary of Equipment Savings

Savings in costs associated with display, storage, and preparation equipment would amount to about one-third of total costs for these factors. Savings may be a little greater, on a proportional basis, for the small stores than for medium and large stores (Table 7).

TABLE 7—Percentage savings in equipment costs for various types of equipment used in retail meat departments resulting from a shift to frozen meats

Store size	Savings by types of equipment			
	Display (Percent)	Storage (Percent)	Preparation (Percent)	Weighted average(*a*) (Percent)
SMALL	0	95	95	36
MEDIUM	0	86	95	34
LARGE	0	75	95	32

(*a*) Weighted on basis of percentage composition of equipment investments.

Space Needs and Costs

Next to labor costs, rent or space costs account for the greatest single outlay by retail meat departments. An average of about 8.5 cents out of each total expense dollar went for rent in stores in three widely separated cities involved in one study of meat retailing costs. (4)

About one-third of space needs for meats is devoted to sales areas and about two-thirds to non-sales areas. (13) Although some space savings may be realized in the sales areas by shifting to frozen meats, more significant changes likely will occur in the preparation and storage areas.

In the average small store in the North Central states there are 154 square feet in the non-sales area of the meat department. (8) An average of 59 square feet of this total is cooler space. Assuming that about 25 percent of all meats (luncheon meats, bacon, and sausage) will not be frozen (12), 25 percent of the 59 square feet, or 15 square feet of cooler space will be needed even if all other meats are frozen (Table 5). Approximately 5 additional square feet may be required for the frozen meat storage cabinet (Table 8). This leaves a total of 134 square feet which may be released from preparation and storage areas in small stores which shift their sales of all red meats from freshly-packaged to frozen meats (Table 8).

TABLE 8—Rent savings resulting from a shift to frozen meats by store sizes

Store size	Space in non-sale areas (sq. ft.)	Storage space needs for non-frozen meats(*a*) (sq. ft.)	Storage space for frozen meats (sq. ft.)	Total space savings(*b*)	
				(sq. ft.)	(%)
SMALL.....	154	15	5	134	87
MEDIUM.....	293	27	10	256	87
LARGE.....	768	60	40	668	87

(*a*) Luncheon meats, bacon, sausage, etc.
(*b*) Column (1) less columns (2) and (3).
Source: Retailing Meats in the North Central States, Sta. Bul. 622, Agr. Expt. Sta., Purdue Univ., Lafayette, Ind., pp. 6, 14, and Supermarket merchandising Vol. 20, No. 10, October, 1955, pp. 73-85.

In the average medium store, total non-sales areas take up 293 square feet, 108 square feet of which are devoted to cooler space. After retaining 25 percent (as explained in the last paragraph above) of the 108 square feet for cooler space needed for luncheon meats, bacon, sausage, etc., and about 10 square feet for a frozen food cabinet,

256 square feet would be released from preparation and storage areas in stores shifting all red meats from freshly packaged to frozen forms. For the average large store, the non-sales area totals 768 square feet, 241 square feet of which are in cooler space. After retaining 25 percent for the luncheon meats, bacon, and sausage groups, plus about 40 square feet for a frozen meat cabinet, 668 square feet can be released from the non-sales area in the meat department (Table 8).

The space saved in the average store in each store size, therefore, represents an 87 percent saving in space costs for the non-sales area. Since non-sales areas require about 67 percent of total meat department areas, the overall saving in meat department space amounts to 58 percent, (67 x 87) as a result of shifting to frozen meats.

Perhaps of greater significance to the entire retail food store, however, is the potential volume of sales and net profit from other merchandise which could be displayed in the area released by a shift from freshly-packaged to frozen meats. For example if the average large-size store used the released space for a sales area for other merchandise and could sell an average of $3.00 worth of goods per square foot per week, the gross sales would amount to about $1900 per week. This would be $19 more net income per week even at one percent net, $38 weekly at two percent net, and $57 weekly at three percent net. Annually this would amount to $988 at a one percent net, $1976 at two percent net, or $2964 at three percent net.

Wrapping Supply Costs

Costs for wrapping supplies account for over 4¢ out of each dollar of total costs in retail meat operations. (4) This may run as high as almost 2¢ for each dollar's worth of meat sold, and in most cases exceeds 1¢ per dollar of sales. (10)

Self-service meat departments have higher wrapping supply costs than service department. (10) Due to the relationship of wrapping materials to the meat products with which they are used, however, wrapping supply costs can be reduced in both self-service and service retail meat departments in direct proportion to the shift from in-store packaging to pre-wrapped meats.

Stores which shift from in-store packaging of freshly-cut red meats to frozen meats which are packaged before reaching the store, therefore, can reduce wrapping supply costs almost to the exact extent of their shift from freshly packaged to frozen meats. Assuming that

all luncheon meats, bacon, and sausage is packaged before reaching the store, retailers who shift their sale of all other meats to the frozen form would dispense with nearly 100 percent of wrapping supply costs. Some costs might still be incurred for materials to repair damaged packages and in some instances stores might want their own price labels.

SUMMARY

This study indicated that the cost of handling frozen meats in retail food stores would be from one-third to one-half of the cost of present methods of handling fresh meats.

Man-hour requirements for handling frozen meats were estimated to be 80 to 90 percent less than for handling fresh meats.

Total investment in meat handling equipment would be 32 to 36 percent less for handling frozen meats. Investment in display equipment would be unchanged but substantial investment reductions in storage and preparation equipment would be possible.

Due largely to the elimination of preparation and storage space, total square feet of floor space devoted to the meat department could be reduced by approximately 58 percent by shifting to frozen meats.

Since all frozen meats would be received in consumer sized units there would be little, if any, wrapping supply costs with frozen meats.

Cost reductions at retail stores associated with a shift to frozen meats would be accompanied by a transfer of the cutting, packaging and weighing of meat to a centralized processing plant. Therefore, it cannot be concluded from this study that total costs of processing, distributing and retailing frozen meat would be less costly than the present system of distribution. Additional information would be necessary to make a more comprehensive cost comparison.

LITERATURE CITED

1. Agricultural Marketing Service (1956). U. S. D. A. The outlook for frozen foods, AMS-154.
2. Anderson, D. L., and P. F. Shaffer (1955). Improved handling of frozen foods in retail food stores, Marketing research report No. 104, Agr. Marketing Service, U. S. D. A.
3. Anderson, D. L., and P. F. Shaffer (1954). Principles of layout for self-service meat departments, Marketing research report No. 77, Agr. Marketing Service, U. S. D. A.

4. Farstad, Edmund, and V. John Brensike (1952). Costs of retailing meats in relation to volume, Marketing research report No. 24, Bur. of Agr. Econ. U. S. D. A.
5. Harwell, E. M., D. L. Anderson, P. F. Shaffer, and R. H. Kwowles (1953). Receiving, blocking, and cutting meats in retail food stores, Marketing research report No. 41, Production and marketing administration, U. S. D. A.
6. Packaging and displaying meats in self-service meat markets (1953). Marketing research report No. 44, Production and marketing administration, U. S. D. A.
7. National Provisioner (Nov. 1955). Consumer frozen meats are on the way, Vol. 133, No. 22, pp. 183-192.
8. North Central Regional Livestock Marketing Research Committee (1955). Retailing meat in the North Central states, North Central regional publication No. 55, Sta. Bul. 622, Purdue Univ.
9. Toothman, J. S. (1956). Survey of distribution practices for prepackaged frozen meat, Marketing research report No. 137, Agr. Marketing Service, U. S. D. A.
10. Wiegmann, F. H., E. S. Clifton and Geoffrey Shepperd (1955). Comparison of costs of service and self-service methods in retail meat departments, Research Bul. No. 422, Iowa State Col.
11. Kramer, R. C. (1952). Retailing prepackaged meat, the effect on sales and labor costs, Spec. Bul. 385, Mich. State Col.
12. Riley, H. M. (1954). Some measurements of consumer demand for meats, unpublished Ph. D. thesis, Mich. State Col.
13. Supermarket merchandising (October 1955) Vol. 20 No. 10.

SOME FUNGICIDE TRIALS ON TREE FRUITS IN 1958[1]

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INTRODUCTION

These comparisons of fungicides in 1958 were made on apples, pears, peaches, Windsor and Montmorency cherries.

General Methods and Materials

The materials tested, their sources, and dosages used on the different fruit crops are listed in Table 1.

For the most part the plots consisted of single trees distributed at random and replicated four times with the exception of pear plots which were sprayed as single rows of six trees each and sweet cherry plots which consisted of four trees planted on a square. All sprays were applied with a hand gun at 450 to 500 lbs. pressure at the pump, and applied through a 12/64″ nozzle disc with some loss of pressure through 80 feet of ⅜″ hose.

EXPERIMENTAL

Fungicide Tests on Apples

Methods: Fungicides were tested on Jonathan and Stayman apples at the Walter Miller Farms near Benton Harbor, Michigan. Jonathan was used for powdery mildew tests and Stayman for scab *(Venturia inaegualis)* control and effect on finish.

All trees were sprayed in the silver tip stage, April 18, with 4 ounces of Phix in 100 gallons. Six comparative sprays were then applied at approximately two-week intervals on Stayman and seven on Jonathan. The Stayman sprays were concluded at third cover,

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TABLE 1—Materials used in 1958 spray experiments

Materials used	Dosages per 100 gallons
1. PRB-32 50% WP	1½ lb. (1); 2 lb. (6); 3 lb. (1)
2. OM-2086 50% WP	1 lb. (1); 2 lb. (6); 3 lb. (1)
3. OM-1763 50% WP	1½ lb. (1); 3 lb. (1)
4. OM G-1143 50% WP	1½ lb. (1) (6)
5. Cyprex 5223 70% WP	½ lb. (1, 2, 3, 5, 6); ¾ lb. (1, 2, 4, 6)
6. Cyprex (phthalate) 23341 70% WP	¼ lb. (3); ½ lb. (3); ¾ lb. (3, 4, 6)
7. Cyprex (borate) 23281 70% WP	¼ lb. (3); ½ lb. (3); ¾ lb. (3, 4, 6)
8. Glyodin-Phix	1 pint—4 oz. (5) (2)
9. Glyodin-Panogen	1 pint—½ pint (5) (2)
10. Glyodin	1 quart (4)
11. Glyodin-Actidione	½ pint—1 tablet (1p.p.m.) (4)
12. Glyodin-sulfur	1 pint—5 lb. (4)
13. Glyodin-Ferbam-sulfur	½ pint—¾ lb.—2½ lb. (1, 4, 6)
14. Captan-ML 104 sticker	2 lb.—½ pint (1, 2, 3, 4, 5, 6)
15. Phaltan-ML 104 sticker	2 lb.—½ pint (3, 4, 6)
16. Actidione-Ferbam	1 tablet (1 p.p.m.)—½ lb. (3)
17. U9547 50% WP	1½ lb. (1, 2, 3)
18. 26% copper-lime	3 lb.—3 lb. (3)
19. 26% copper-sulfur-lime	1½ lb.—3 lb.—3 lb. (4)
20. Bordeaux 3-6-100	CuSO4 3 lb. lime 6 lb. (5)
21. Bordeaux 2-6-100	CuSO4 2 lb. lime 6 lb. (5)
22. GC 2466 50% WP—Plyac sticker	1½ lb.—½ pint (2)
23. Phybam S	4 lb. (1)
24. Thylate 65% WP	1½ lb. (4)

(1) Jonathan apples.
(2) Stayman apples.
(3) Montmorency cherries.
(4) Schmidt and Windsor sweet cherries.
(5) Bartlett pears.
(6) Halehaven peaches.

Description of Materials used and sources

PRB-32, OM 2086, OM 1763 and OM G-1143 were50 % wettable powders of undisclosed formula furnished by Olin Mathieson Chemical Corporation.

Cyprex 5223 (dodecylguanadine acetate) 70% W.P.; Cyprex 23341 (dodecylguanadine acid Phthalate); and Cyprex 23281 (dodecylguanadine borate) 70% W.P. were furnished by the American Cyanamid Company.

Glyodin (2-heptadecyl-2-imidazoline acetate) was furnished by Carbide and Carbon Chemical Company.

Phix (phenylmercury acetate) 20% W.P. was furnished by Chemley Products Co., Chicago, Illinois.

Panogen (methylmercury dicyandiamide 4.4% liquid) was furnished by Panogen Company, Division of Morton Chemical Company, Ringwood, Illinois.

Captan, 50% W.P. (N-trichloromethylthio-4-cyclohexene-1, 2, dicarboximide).

Phaltan (formula not given) and ML 104 spreader (formula not given) were furnished by California Spray Chemicals Company.

Actidione (cycloheximide), and U9547 (formula not given) were furnished by Upjohn Company.

26% copper (basic copper sulfate) is a product of the Tennessee Copper Co.

GC 2466 50% W.P. and Plyac sticker (formulas not disclosed) were furnished by the General Chemical Company.

Ferbam (ferric dimethyldithiocarbamate) and Thylate (tetramethylthiuramdisulfide) are products of the DuPont de Nemours and Company, Inc.

Phybam S (a mixture of 75% wettable sulfur, 18% Ferbam and 6% Phygon) is a product of Corona Chemical Division, Pittsburgh Plate Glass Company.

July 2. An additional fourth cover spray was applied to Jonathan on August 1. Spray dates were April 25, May 6 and 21, June 4 and 17, July 2, and an extra spray on Jonathan August 1.

Powdery Mildew Control: Sulfur has long been considered the best known material for powdery mildew (*Podosphaera* sp.) control. Therefore Phybam containing 3 lbs. of sulfur and also a combination of Ferbam, ¾ lb., sulfur 2½ lb. and Glyodin ½ pint were included for comparison.

Final mildew readings were taken July 31. About 100 shoots were selected at random and those showing mildew were recorded. The unsprayed check trees had an average of 34 percent mildewed shoots. While reduction up to 50 percent was indicated for many of the materials, only G-1143 approached the 2 to 3 percent mildew count resulting from those sprays containing 2½ to 3 lbs. of sulfur such as Phybam and the Ferbam-sulfur-Glyodin combination. G-1143 was the only one of the new materials that indicated promise for further testing. Comparative powdery mildew control is indicated in Table 2.

TABLE 2—Powdery mildew control on Jonathan apple trees

Material	July 31 reading mildewed shoots Percent
PRB-32 1½ lbs.	18.0
PRB-32 1 lb.	12.5
OM 2086 1 lb.	15.0
OM 2086 2 lbs.	13.0
OM 1763 1½ lbs.	18.0
OM 1763 3 lbs.	20.0
Captan 1½ lbs.	26.5
Cyprex ¾ lb.	15.0
Upjohn 1½ lbs.	13.0
Phybam 4 lbs.	2.0
Ferbam, sulfur, Glyodin	3.5
OM G-1143 1½ lbs.	3.5
Checks	34.0

Scab Control: Scab did not develop on the sprayed trees or on the check due to weather conditions.

Fruit Finish: As low temperatures and some frost killing of blossoms occurred in the early season, it would be expected that some

of the russeting encountered was directly the result of frost injury. This natural russeting would be reflected in the check fruits but nevertheless the checks received insecticides separately which could have contributed to russeting. On Jonathan russeting noted around the stem-end cavity appeared fairly uniform regardless of sprays used but the differences in severe cheek russeting indicated spray influence. PRB-32, OM-1763, G-1143 and Captan sprayed fruits showed little or no cheek russet and in this category small differences in percentage are probably significant. Ferbam is well known for affecting the finish of Jonathan fruit. It is of interest that the combination of Ferbam-sulfur-Glyodin resulted in the most russeting; whereas, the Ferbam-sulfur-Phygon combination in Phybam showed only half as much. This may result from an increase of Ferbam deposit or longer retention on the fruit when used with Glyodin. The counts for Jonathan are given in Table 3.

For Stayman apples the russet counts are given in Table 4. The combination of Glyodin with mercuries resulted in no injury compared with the check fruit. The large amount of russeting on the ¾ lb.. Borate Cyprex plot was readily visible by a casual glance at the samples. The degree of russeting for the borate and phthalate salts of Cyprex increased according to the concentration. The fruit sprayed with ½ lb. of regular Cyprex could not be distinguished from Captan in the samples but at least three deeply cracked and

TABLE 3—Effect of spray material on russeting of Jonathan apples

Materials	Fruits number	Stem end russet percent	Severe russet percent
PRB-32 1½ lb.	152	73.0	0.0
PRB-32 1 lb.	150	69.0	0.0
OM 1763 1½ lb.	152	70.0	0.0
OM 1763 3 lb.	157	74.0	0.0
OM 2086 1 lb.	147	76.0	4.1
OM 2086 2 lb.	146	73.0	2.0
G-1143 1½ lb.	140	57.0	0.0
Check ——	54	59.0	2.2
Captan 2 lb.	145	63.0	0.8
Cyprex ½ lb.	134	69.5	3.7
Upjohn 9547 1½ lb.	154	64.0	4.6
Phybam 4 lb.	134	58.0	3.0
Ferbam, sulfur, Glyodin	157	58.0	7.0

Jonathan finish 10/11/58.

TABLE 4—Effect of certain fungicides on russeting of Stayman apple

	Stem end russeting percent	Basin end russeting percent	Cheek russeting	
			Slight percent	Severe percent
1. Phix-Glyodin	6.7	0.0	13.3	0.0
2. Panogen-Glyodin	30.0	0.0	13.3	0.0
3. Captan	50.0	3.3	6.6	10.0
4. Cyprex ¾ lb.	47.0	0.0	13.3	6.6
5. General Chem.	57.0	6.7	13.3	6.6
6. G-1143	60.0	13.3	13.3	13.3
7. Phthalate cyprex ¼	40.0	3.3	3.3	13.3
8. Phthalate cypress ½	57.0	10.0	6.6	10.0
9. Phthalate cyprex ¾	60.0	16.6	22.3	33.3
10. Borate cyprex ¼	53.0	13.3	16.6	16.6
11. Borate cyprex ½	63.0	37.0	30.0	13.3
12. Borate cyprex ¾	87.0	63.0	20.0	63.3
13. Check (insecticide only)	16.0	3.3	16.0	0.0

russeted apples had been removed from one of the trees earlier. These cracked fruits were typical of Cyprex injury seen the previous year.

For Stayman apples, the presence or absence of russeting around the basin at the sepal end of the fruit appeared correlated with the fungicide used and was perhaps the most definite criterion of spray injury. The borate Cyprex gave serious russeting, particularly at the higher dosages. The russeting by other materials was of little consequence with the least found on the Glyodin-mercury plots.

Fungicide Tests on Sweet Cherries[1]

Methods: Four applications of comparative sprays on sweet cherries were made at 2-week intervals beginning at petal fall. Insecticides (DDT and parathion) were applied separately. Leaf spot *(Coccomyces hiemalis)* was not present. Two separate samples of Windsor sweet cherries were picked on July 9 and July 16, 13 and 20 days after the last spray application. The early-picked samples were immature and did not show brown rot after two weeks of room-temperature storage. The later samples, picked following a two-day rain, exhibited cracking ranging from 13 to 95 percent. There were also variations in total rots including brown rot *(Mono-*

[1]The invaluable assistance of James Friday, Coloma, Michigan in taking samples and making counts is gratefully acknowledged.

linia fructicola), gray mold *(Botrytis* sp.*)* and *Rhizopus*, and differences in fruit size and maturity. The data for the July 16 samples are presented in Table 5.

TABLE 5—Effect of certain fungicides on fruits of Windsor sweet cherries

Materials	Fruits number	Sound(*a*) fruits percent	Cracked fruits percent	All rots percent	Brown rot percent	Average weight single fruit ounces	Gain or loss percent	Maturity estimate
1. Copper-sulfur-lime....	135	87	13.0	0.7	0.0	.186	−7.0	full-ripe
2. Phaltan-sticker.....	69	71	29.0	11	4.3	.236	16.0	ripe
3. Sulfur-glyodin.....	71	60	40.0	1.4	1.4	.215	7.0	med. ripe
4. Grower's program.....	70	58	41.5	1.4	1.4	.221	10.0	ripe
5. Thylate.....	78	33	67.0	5.1	0.0	.200	0.0	ripe
6. Cyprex (phthalate) ...	79	29	71.0	21	6.3	.200	0.0	ripe
7. Captan-sticker.....	71	28	72.0	17	4.2	.218	9.0	ripe
8. Ferbam-sulfur-glyodin	79	26	74.0	6.3	0.0	.202	1.0	med. ripe
9. Actidione-glyodin.....	80	22	77.0	6.2	0.0	.175	−12.5	green(*b*)
10. Check (insecticide only).....	72	18	82.0	23	22.0	.201	0.0	med. green
11. Cyprex.....	74	12	88.0	22	5.5	.206	3.0	ripe
12. Glyodin.....	80	7	93.0	15	2.5	.203	1.5	ripe
13. Cyprex (borate).....	91	4	96.0	33	10	.181	−10.0	ripe

(*a*) Not cracked or rotted.
(*b*) Green indicates immaturity rather than color of fruit.

Influence of Sprays on Cracking: Copper, calcium, or aluminum salts applied 20 to 35 days before picking were found to reduce cracking of sweet cherries in Washington.[2] The data presented here for the copper-sulfur-lime spray corroborates this and other reports. However, the influence of other materials on the increase of cracking was not foreseen. It would appear that surfactant materials such as Cyprex and Glyodin increase cracking.

Control of Fruit Rots: The continuing influence of certain materials in control of rot in this test was seen 20 days after the last spray application. The copper-sulfur-lime, sulfur-Glyodin, and the grower's applications consisting of 3 early Ferbam-sulfur sprays and 3 later Captan sprays were effective in retarding all rots. The Thylate, Ferbam-sulfur-Glyodin and Actidione-Glyodin sprayed trees had a low incidence of brown rot; whereas, the fruit on the check trees showed a large amount of brown rot.

Effect of Spray Materials on Maturity and Size: The Actidione-Glyodin sprayed cherries were markedly delayed in ripening, and significantly smaller in size. All the other materials showed darker,

[2]Bullock, R. M. 1952. A.S.H.S. 59:243-53.

more mature fruit than the check trees, while the copper-sulfur-lime sprayed trees had fruit more uniformly dark and mature than that on any other treatment, but slightly smaller in size than normal. The Phaltan, Captan and sulfur sprayed fruits were above average size.

Tests on Pears

Methods: Glyodin is an established fungicide for apples and sour cherries and imparts surfactant and sticking qualities when used in combination with insecticides and other fungicides. It has received limited attention as a pear spray. Cyprex is a more recent fungicide not previously tested on pears. Therefore Glyodin alone, and in combination with Ferbam, Phix and Panogen was compared with Bordeaux, Captan, Ferbam and Cyprex.

A Bartlett pear orchard in Berrien County with a heavy carry-over of scab inoculum was selected for the test. Three sprays of each test material were applied consisting of pre-bloom, petal fall and first cover (two weeks after petal fall). Three pounds of lead arsenate in 100 gallons of spray were included with each spray. In addition all plots were sprayed in early bloom with 2-8-100 Bordeaux for protection against the bacterial "fireblight" disease. Scab and fireblight did not develop. Only fruit finish results were obtained.

Fruit Finish: Except for those trees sprayed with Bordeaux 3-6-100 little difference in finish resulted from any of the materials used. Plots sprayed with Bordeaux 3-6-100 were heavily russeted at the lenticels. The Bordeaux injured fruit was satisfactory for commercial processing. The weaker Bordeaux 2-8-100 applied to all plots in full bloom had little damaging effect on the fruit in this season.

In this experiment Glyodin, Phix, Panogen, and Cyprex appeared promising as fungicides for pears, the resulting fruit showing finish equivalent to that sprayed with Ferbam and Captan.

Tests on Peaches

Methods: Two tests were conducted on Halehaven peaches. At the Friday orchard, Coloma, 10-year-old peach trees interplanted in a sweet cherry orchard received the same test fungicides applied to sweet cherries. In addition they received two extra sprays, applied July 31 and August 12, in their final month on the trees. Samples were harvested on August 22 — 10 days after the last spray. No rot

was apparent at harvest. The samples were stored 14 days in a dark basement in which the temperature averaged 68° F. The final rot determinations were made September 6.

Although attempts were made to pick fruit of comparable ripeness there was considerable variability between plots. The sulfur-sprayed fruits were greener and more immature than the others, while Phaltan sprayed fruits were of uniformly good color. The early sprays of Phaltan resulted in marked injury consisting of leaf yellowing and defoliation but only traces of injury were observed following the last two sprays. Sulfur and Phaltan gave the best rot control in this test. The rot count is given in Table 6.

TABLE 6—Results of spray tests on Halehaven peaches at Coloma

Materials used	Fruits number	Rots(*a*) percent	Remarks
Sulfur 5 lb. Glyodin 1 pint	52	0.0	Immature on tree
Phaltan 2 lb. ML 104 spreader ½ pt.	119	0.0	All good color
Actidione .38 g, Glyodin ½ pt.	116	6.9	2 cracked, 1 bumpy
Cyprex, ¾ lb.	121	7.5	
Cyprex (Phthalate) ¾ lb.	107	7.5	
Ferbam ¾ lb., sulfur 2½ lb., glyodin ½ pt.	65	15.4	
Thylate 1½ lb.	117	20.0	Brown rot and rhizopus
Cyprex (borate) ¾ lb.	120	20.0	
Check (insecticides only)	120	23.4	Mostly brown rot
Captan 2 lb., ML 104 spreader ½ pt.	78	31.0	Mostly rhizopus

(*a*) Mostly brown rot but Rhizopus rot was prevalent in Captan and Thylate sprayed plots.

The spray tests at the Point Sable orchard, Shelby, Michigan, were applied to Halehaven trees three weeks and one week before harvest — August 12 and September 4. The fruit was picked September 9 and stored on wire mesh trays in a dark screened room. The room was sprayed occasionally with Standard Oil Company Aerosol household insecticide which kept fruit flies from multiplying. Rot determinations were made on September 17 — eight days after picking. In addition to rot counts notes were taken on skin cracking. Skin cracking was severe on sulfur sprayed fruits, and a trace or more was observed on fruits sprayed with G-1143, Cyprex and OM-2086.

Sulfur, PRB-32, 2086 and G-1143 were the most effective materials for brown rot control in this test. The results are given in Table 7.

TABLE 7—Results of spray tests on Halehaven peaches—Shelby, Michigan, 1958

	Fruits	Total rots	Brown rot %	Observed skin cracking at harvest
1. PRB-32 2 lb.	156	5.2	2.6	No cracking
2. 2086 2 lb.	156	7.6	3.8	Tr. cracking
3. G-1143 2 lb.	99	6.0	3.0	Cracking +
4. Captan—ML 104 sticker.	129	11.6	4.6	No cracking
5. Sulfur—glyodin.	131	6.1	2.3	Severe fruit cracking
6. Cyprex.	114	31.8	30.0	Trace fruit cracking
7. Phthalate Cyprex.	63	19.1	12.7	No cracking
8. Borate Cyprex.	127	11.1	7.9	No cracking
9. Check.	178	16.9	9.0	No cracking

Tests for Cherry Leaf Spot Control

Methods: The experiments were conducted with six-year old cherry trees at the Walter Miller farms, Benton Harbor, Michigan. Four pre-harvest sprays were applied, except for the Actidione-Ferbam combination which was applied only three times, omitting the petal-fall spray. Two pounds of lead arsenate in 100 gallons was added to each spray. The after-harvest spray was purposely omitted to intensify possible differences in leaf spot control.

The spray dates were May 23, June 5, 18, and 26. Injury observations were made on July 9 and 30. Leaf spot ratings were made on September 14 and final defoliation was estimated and recorded on October 15. Fruit was harvested by random sampling on July 14. Soluble solids were determined with an Abbe refractometer.

Injury from Sprays: The first indication of lead arsenate injury was apparent in the few yellowed leaves seen on July 9. The injury was intensified in most plots by July 30 and was still present but less apparent on September 14. The copper sprayed plots showed typical copper injury, which accounted for an estimated final 40 percent loss of the foliage. Spray injury from the other materials, including lead arsenate, while conspicuous, was of minor importance amounting to less than 1 percent total leaf loss in the most severe cases. The relative injury is included in Table 8. All of the materials or combinations of materials used retarded lead arsenate injury.

Fruit Size, Sugar Content and Maturity: Only two treatments significantly reduced the size of fruit, the Actidione-Ferbam combination

TABLE 8—Injury, leaf spot infection and defoliation following differen spray treatments on Montmorency cherries

	Lead and copper(*a*) spray injury		Infection defoliation	
	July 9 estimate	July 30 rating(*b*)	Sept. 14 rating(*b*)	Oct. 14 rating(*b*)
Cyprex (phthalate) ¼ lb.	trace	4	4	4
Cyprex (phthalate) ½ lb.	0	3	3	3
Cyprex (phthalate) ¾ lb.	0	2	2	2
Cyprex (borate) ¼ lb.	trace	3	3	4
Cyprex (borate) ½ lb.	trace	2	2	3
Cyprex (borate) ¾ lb.	0	2	2	2
Cyprex ½ lb.	trace+	2	0	3
Captan-sticker	trace	1	2	4
Phaltan-sticker	trace+	1	0	2
Ferbam-Glyodin	trace+	1	1	4
Actidione-Ferbam	trace+	1	6	9
Upjohn U9547	++	1	0	2
Check (no sprays)	0	0	9	10
26% copper-lime	trace	5	0	5

(*a*) The injury and defoliation on the copper sprayed plot was attributed to copper injury entirely.
(*b*) Rating—10 most severe.

and copper-lime. The copper-lime treatment also resulted in a higher sugar concentration indicating, perhaps, a lower water content of the fruit. Data for fruit size, color, maturity and soluble solids are given in Table 9. Previous experiments in Michigan did not show appreciable reduction in fruit sze from the use of low soluble copper sprays possibly since tests in previous years involved the use of only three preharvest sprays (Cation and Robertson, 1938; Rasmussen, 1937 and 1938). When using Bordeaux, the last spray before harvest is considered most important for fruit size reduction. None of the other materials dwarfed the fruit or appreciably influenced the sugar content in 1958 tests. Actually, fruits in most of the plots were slightly larger than the checks. The check trees were replants several years younger than the sprayed trees, and it is common observation that younger cherry trees produce smaller fruits than more mature trees.

Fruit maturity and color differences were associated with the spray treatments. Fruits sprayed with copper-lime, Captan, Phaltan, Upjohn U9547 and those unsprayed appeared of normal color. Cyprex ½ lb., borate Cyprex ¾ lb., and Actidione-Ferbam sprays resulted in noticeably light colored fruits; whereas, those sprayed with the other

compounds were intermediate. The Cyprex, ½ lb. plot showed fruit immature and not ready to pick on July 14 as indicated by the difficult separation of the fruit from the stems, resulting in tearing the fruit and so-called bleeding. It may well be that Cyprex gives a maturity-retarding or growth-regulating reaction somewhat similar to growth regulating hormones, as a similar delay of foliage maturity was indicated in 1957 when leaf fall was delayed (Cation, D. 1957). However, to present knowledge, immaturity has not been attributed to Cyprex elsewhere.

Leaf Spot Infection: No leaf spot appeared in the plots until after harvest, July 30, when one infected leaf was noticed on one unsprayed check tree. However, by September 14, infection was severe on the checks and on the Actidione-Ferbam plots although defoliation from the disease had not yet occurred. Only moderate infection was observed on the other plots and none was noted for the Phaltan, Upjohn U9547 or Cyprex plots. The estimated infection for September 14 and defoliation for October 14 is included in Table 8.

Defoliation of terminal shoots on individual trees within a plot varied from 10 to 50 percent. This defoliation was more prevalent on the northwest side of the tree and was frequently negligible on the southeast side. Therefore only an over-all rating of the materials

TABLE 9—Size, soluble solids and condition of Montmorency cherry fruit at harvest time

Materials	Color(*a*)	Maturity(*b*)	Cherries per lb. number	Soluble solids percent
Cyprex (phthalate) ¼ lb.	medium	mature	94.5	15.0
Cyprex (phthalate) ½ lb.	medium	mature	105.5	14.1
Cyprex (phthalate) ¾ lb.	medium	mature	108.5	14.7
Cyprex (borate) ¼ lb.	medium	mature	106.5	14.7
Cyprex (borate) ½ lb.	medium	mature	113.0	14.3
Cyprex (borate) ¾ lb.	light	mature	102.5	15.0
Cyprex ½ lb.	light	immature	106.0	14.0
Captan-sticker	dark	mature	105.0	14.0
Phaltan-sticker	dark	mature	103.5	14.0
Ferbam-glyodin	medium	mature	110.5	14.5
Upjohn U9547	dark	mature	107.0	....
Copper-lime	dark	mature	123.0	18.3
Actidione-Ferbam	light	mature	124.0	13.7
Check (no sprays)	dark	mature	111.0	14.5

(*a*) Light red to dark red.
(*b*) Mature fruit separated readily from the stem.

was attempted rather than making detailed counts. Defoliation o individual trees is given in Table 10. Phaltan, Upjohn U9547 an the analogues of Cyprex at the ¾ lb. dosage brought the trees t the end of the season holding most of their foliage. Cyprex at th ½ lb. dosage was only slightly less favorable. It would appear tha the ½ lb. dosage for Cyprex is adequate (Cation, D. 1957) but ap proaches the minimum for such long range protection. The Octobe 14 observations were 3½ months after the last spray coverage. Th Glyodin-Ferbam combination and Captan treatments showed mor foliage loss than the above materials but gave practical control i this experiment. All of the trees treated with 1 p.p.m. Actidione plu ½ lb. of Ferbam had conspicuously few leaves and the check tree were completely bare by October 14.

TABLE 10—Defoliation of terminal shoots on individual trees of Mon morency cherries

	Tree 1 %	Tree 2 %	Tree 3 %	Tree 4 %	Average %
Phthalate Cyprex ¼ lb.	..	90	25	15	43
Phthalate Cyprex ½ lb.	15	25	50	15	26
Phthalate Cyprex ¾ lb.	15	20	50	10	24
Borate Cyprex ¼ lb.	50	10	50	50	40
Borate Cyprex ½ lb.	25	10	50	50	34
Borate Cyprex ¾ lb.	10	20	50	10	22
Cyprex ½ lb.	25	35	10	50	30
Captan 2 lb., ML-104 sticker ½	25	75	35	50	46
Phaltan 2 lb., ML sticker ½ pt.	10	10	35	25	20
Upjohn 9547 1½ lb.	20	10	25	25	20
Ferbam ¾ lb., Glyodin ¾ pt.	20	40	50	50	40
26% Copper 3 lb., lime 3 lb.	40	15	50	90	50
Actidione 1 ppm, Ferbam ½ lb.	95	90	95	75	90
Check (no sprays)	100	100	100	100	100

SUMMARY AND CONCLUSIONS

Twenty-four fungicidal materials, or combinations of materia were variously tested on apples, pears, peaches, and sweet and sou cherries. Comparative apple scab control was not determined. Diffe ences were obtained in powdery mildew counts on apples, late seaso counts of leaf spot on Montmorency cherries, fruit rot counts o peaches, and sweet cherries, cracking of sweet cherries and injuries all tests.

Of the Olin Mathieson materials, OM PRB-32, OM 1763 and OM G-1143, showed no perceptible injury to Jonathan apples. OM-2086 caused some fruit russet. All of these materials showed some degree of brown rot control on peaches. G-1143 showed promise in control of powdery mildew on apples.

Cyprex at ½ and ¾ lb. dosage on Stayman and Jonathan apples ranked favorably in fruit finish with other materials. Cyprex showed no practical control of powdery mildew. On Bartlett pears it showed no injury and resulted in satisfactory fruit finish. Cyprex did not control brown rot on sweet cherries or peaches and seemed to increase cracking of the cherries. One-half pound Cyprex gave good control of leaf spot on sour cherries but retarded fruit ripening.

The borate and phthalate salts of Cyprex were indicated as possible materials for sour cherry leaf-spot control. The borate salt materially increased russeting of Stayman apples and fruit cracking on sweet cherries.

Glyodin in combination with mercuries (Phix and Panogen) resulted in favorable fruit finish on Stayman apples, and Bartlett pears. In combination with Ferbam it increased russeting on Jonathan apples. Glyodin alone and in combinations appeared to increase cracking of sweet cherries. A Ferbam-Glyodin combination again gave satisfactory leaf spot control on Montmorency cherries but appears to need protective renewal sooner than copper sprays, Phaltan or Cyprex. Pears sprayed with Glyodin alone or in combination had good finish.

Captan was used only with ML-104 sticker. It was not outstanding in rot control on peaches or sweet cherries, and showed a late season breakdown in protectiveness on sour cherries. It does not control powdery mildew on apples. Phaltan was second best in reducing cracking of sweet cherries. It was effective against brown rot on peaches and sweet cherries but gave severe foliage injury and defoliation in early sprays on peaches and less severe injury, consisting of a few burned spots, on sweet cherry leaves. It was outstanding in leaf spot control on sour cherries.

U9547 gave good leaf spot control but was least active of all materials in correcting lead injury on Montmorency cherries. Its activity against apple mildew is not enough for good control.

Actidione at 1 p.p.m. used with Glyodin reduced the size of sweet cherries, distorted the fruit, retarded ripening and injured foliage. Apparently it should not be used in early season applications and

only later if leaf spot control is more important than possible injury In combination with Ferbam, Actidione 1 p.p.m. applied to Mont morency cherries retarded fruit size in three preharvest sprays and with no long range protectivity it left the trees vulnerable to late season defoliation. Actidione appears best suited to later application on sour cherries when fruit is beginning to color and back-action is indicated. Previous tests indicate that 1½ to 2 p.p.m. is the best dosage for such conditions.

The value of GC-2466 for apple scab control was not determined Bordeaux 3-6-100 resulted in severe lentical russeting of pears but one spray of 2-6-100 in the open blossom stage did not appear to influence the finish in this season.

A combination of low soluble copper plus sulfur and lime was outstanding in rot control and in preventing cracking of sweet cherries However, it gave an unfavorable residue for fresh fruit sales. Low soluble copper plus lime again controlled leaf spot on sour cherries but resulted in reduced fruit size and foliage injury.

Thylate showed good indications in control of brown rot but had no deterrent effect on fruit cracking of sweet cherries.

Phybam and Ferbam-sulfur-Glyodin, both containing equivalent amounts of sulfur, were outstanding in retarding powdery mildew infection on Jonathan apples. This test showed the value of 2 to 3 lbs of sulfur included in early apple sprays where mildew is a problem

LITERATURE CITED

Cation, D. (1957). "Two years results of testing Cyprex for control of cherry leaf spot in Michigan." Plant Dis. Reptr. 41(12):1029-1031.

_____ (1958). "Comparison of fungicides for control of cherry leaf spot in 1956 and 1957." Mich. Agr. Expt. Sta. Quart. Bul. 40(3):609-619

Cation, D and C. W. Robertson (1938). "Basicop as a cherry spray." Mich Agr. Expt. Sta. Quart. Bul. 20(4):199-210.

Rasmussen, E. J. (1937). "Effect of some copper and sulphur fungicides on the tree and fruit of Montmorency cherry." Mich. Agr. Expt. Sta. Quart. Bul 19(3):132-142.

_____ (1939). "Spraying investigations for 1939." State Hort. Soc Ann. Rept. 69:114-121.

A PROGRESS REPORT ON THE DEVELOPMENT OF A MECHANICAL CUCUMBER HARVESTER[1]

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THE FARM VALUE of pickling cucumbers in the United States is about $20 million annually. Michigan growers receive about 5 million dollars for their crop each year. The pickling cucumber grower now pays more than 50 percent of the value of the crop for harvest, which means that Michigan alone pays over $2½ million for the harvest of the pickling cucumber crop. Most of the money for harvest goes to Mexican National laborers, because of the lack and unwillingness of local labor. The recruiting and importing of Mexican National laborers has become more expensive and difficult during the past five years. These two factors — harvest expense and labor procurement — have been responsible for the interest in the development of a mechanical cucumber harvester.

A search for existing machines revealed four experimental cucumber harvesters and a vine trainer in various stages of development. Arrangements were made to test these machines during the 1957 and 1958 seasons. Another harvester and a pneumatic vine trainer were invented, constructed and tested by Michigan State University personnel in 1958.

Description of Machines

The Craig machine (Fig. 1) consists of a set of five finger-like devices 24 to 30 inches long on each side of the row. At the base of each finger is a set of stationary knives. As the machine moves forward the vines are lifted and carried toward the knives by means of V-belts located within each finger. In theory, the fruit hangs down between the fingers, is severed from the vine, drops onto a belt, and is carried to a crate.

[1]The cooperation and financial assistance of members of the National Pickle Packers Association is gratefully acknowledged.

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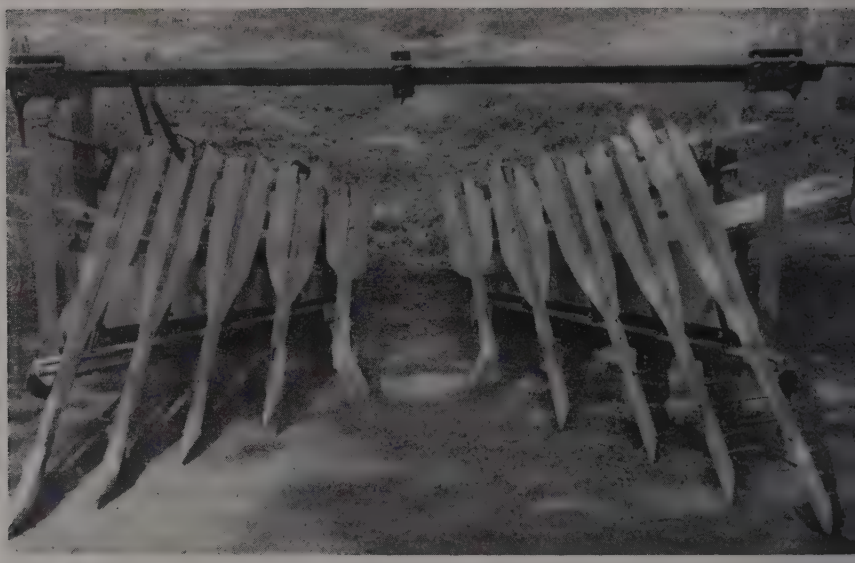

Fig. 1. The Craig experimental cucumber harvester as received at Michigan State University.

This machine was not successful because vines became entangled around the fingers and knives. The following mechanical devices (Fig. 2) were added to the Craig machine in an effort to make it

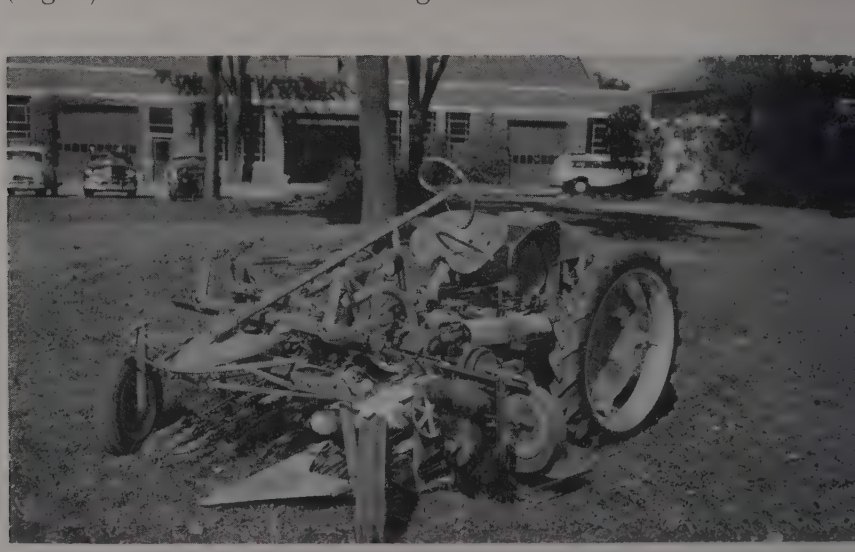

Fig. 2. The Craig machine as modified at Michigan State University.

more effective. A sheet metal nose was placed on the leading edge of the fingers on one side of the row. An overhead canvas belt was added to assist in moving the vines over the fingers. A fan driven by an auxiliary engine was used to supply an upward blast of air from below each knife. This air blast helped keep the knives clear of leaves, but none of these devices enabled the machine to do a satisfactory job. No cucumbers were harvested with the Craig machine.

The Grew Belt machine consists of a sponge rubber roller and two rubber belts which act as a pickup and fruit removal mechanism (Fig. 3). A set of rotating spiral rods serve as a separating device to shake the cucumbers from the mass of vines and as an auger to move the fruit to a conveyor which elevates it to a storage unit.

Fig. 3. Grew Belt experimental cucumber harvester.

The principle of the Grew Belt machine is shown schematically in Fig. 4. Leaves are caught between the sponge rubber roller and the lower rubber belt. The ends of the vines are lifted leaving the root in the ground. After being lifted, the vines are forced between two rubber belts. Many cucumbers are snapped from the vines during this abrupt turn. Some cucumbers are thrown forward onto a conveyor while others are tangled in the vines and pass between the rubber belts onto the separating bed where the loose cucumbers

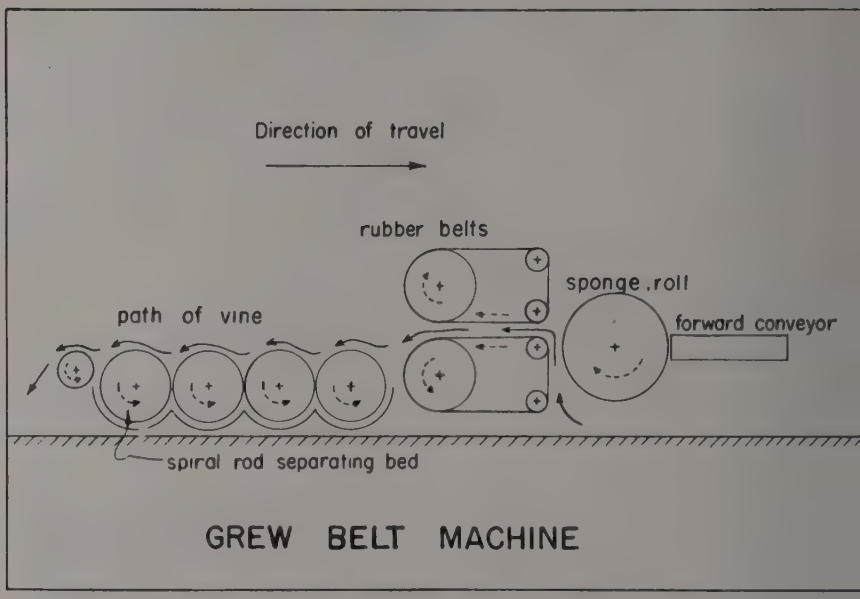

Fig. 4. Schematic drawing of Grew Belt machine.

are shaken out. The vines drop back onto the ground as the machine moves forward. There is some tendency for the machine to drag the ends of the vines ahead, producing a herringbone effect.

The Grew Belt machine is a "one-way" machine; therefore, the vines must be trained to one side of the row. Training has been accomplished by either a modified side delivery rake or a pneumatic vine trainer.

The Grew Roller machine (Fig. 5) is similar in principle to the Grew Belt machine. The separating bed was unsatisfactory so it was replaced by a reciprocating type separating bed (Fig. 6). The bed is made of 5/16 inch rods spaced 8 inches apart which reciprocate at approximately 300 cycles per minute with a 6 to 8 inch stroke.

The pickup mechanism consists of four sponge rubber rollers arranged as shown in Fig. 7. Leaves are grasped by the two leading rollers causing the ends of the vines to pass between the rollers onto the separating bed. Very few cucumbers are removed by the rollers. Most of them are removed as the vines pass over the separating bed.

The Grew Roller machine mounts on a three-point hitch and may be detached quickly from the tractor. It is also a "one-way" machine.

Fig. 5. Grew Roller experimental cucumber harvester as received at Michigan State University.

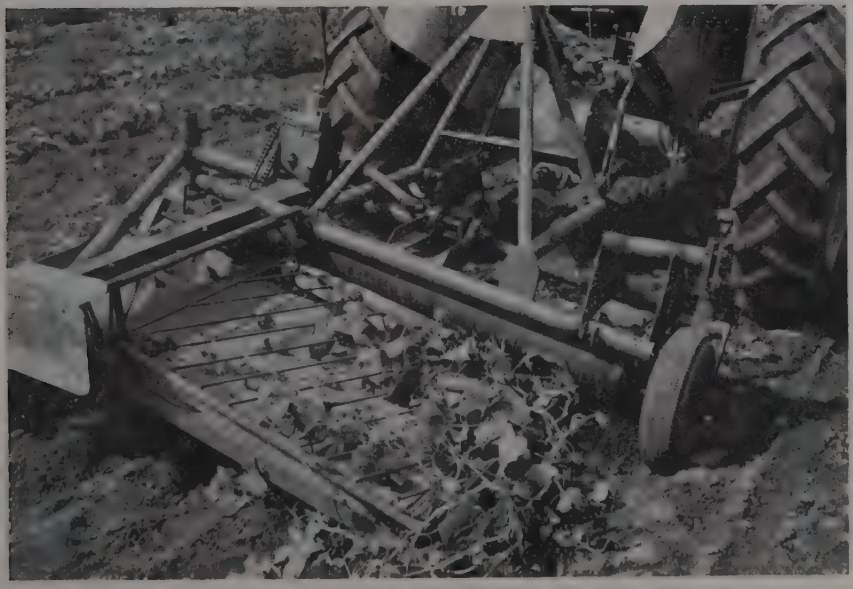

Fig. 6. Grew Roller machine with reciprocating type separating bed.

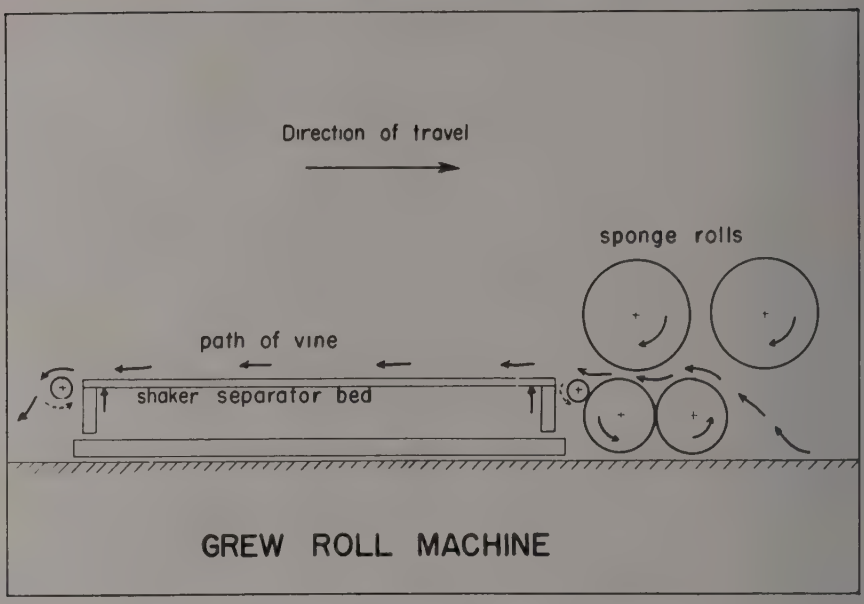

Fig. 7. Schematic drawing of Grew Roller machine.

The Chisholm-Ryder machine is the largest and most complete unit tested (Fig. 8). It is a "two-way" machine requiring no vine training. The pickup mechanism is attached to the leading edge of the separating bed. Fig. 8 shows the machine with two different types of pickup noses, both using V-belts to carry the ends of the vines over the sheet metal noses to the separating bed. A different type pickup nose (Fig. 9) used V-belts and powered rollers on the leading edge. These devices (Fig. 8 and 9) were not completely satisfactory, because they tended to dig into loose soil, tangle vines, and become plugged with dirt and small stones.

The latest type pickup device (Fig. 10) consists of a series of steel or rubber fingers mounted on a tapered drum. Only a few tests were completed with this device, but it was the most successful pickup used on the Chisholm-Ryder machine.

The separating beds used on the Chisholm-Ryder machine consist of roller chains with ⅞-inch rollers 4 feet long and spaced 15 inches apart. The rollers move perpendicularly away from the row at approximately 320 feet per minute. The size of the fruit harvested may be controlled somewhat by varying the speed of the roller chain. As faster speeds are used, smaller fruit are harvested. The fruit is either

Fig. 8. Chisholm-Ryder experimental cucumber harvester.

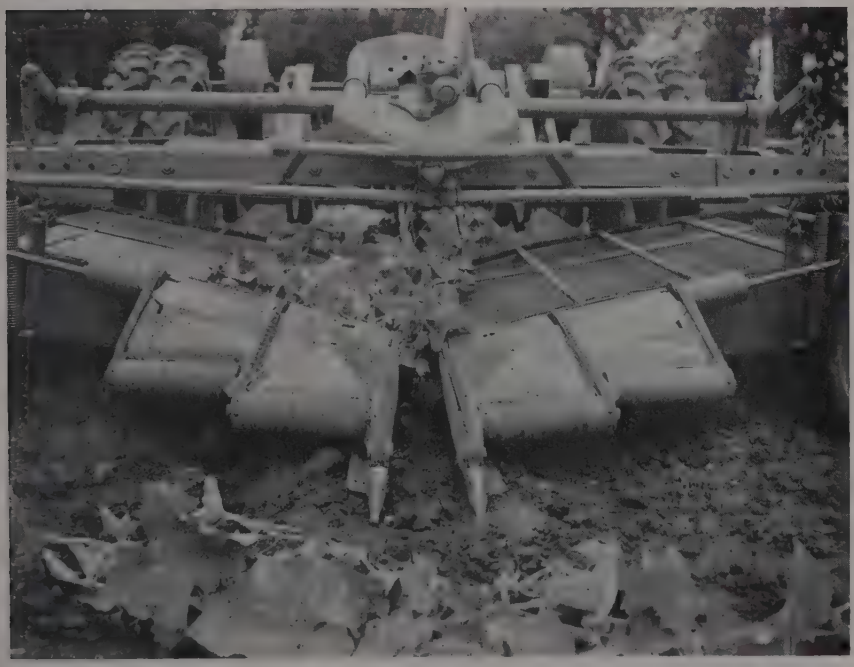

Fig. 9. Chisholm-Ryder machine with powered roller pickup developed by the Fox Brothers Machine Company.

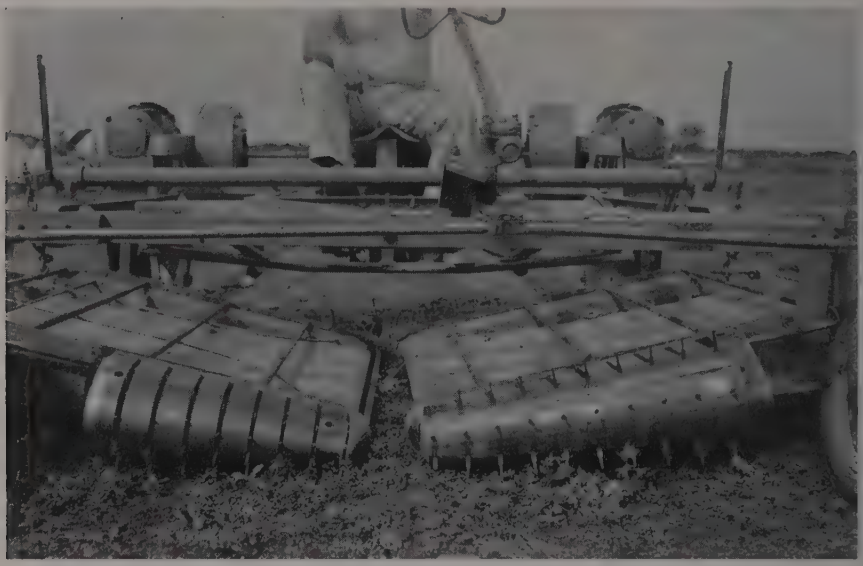

Fig. 10. Chisholm-Ryder machine with tapered roller pickup developed by the Fox Brothers Machine Company.

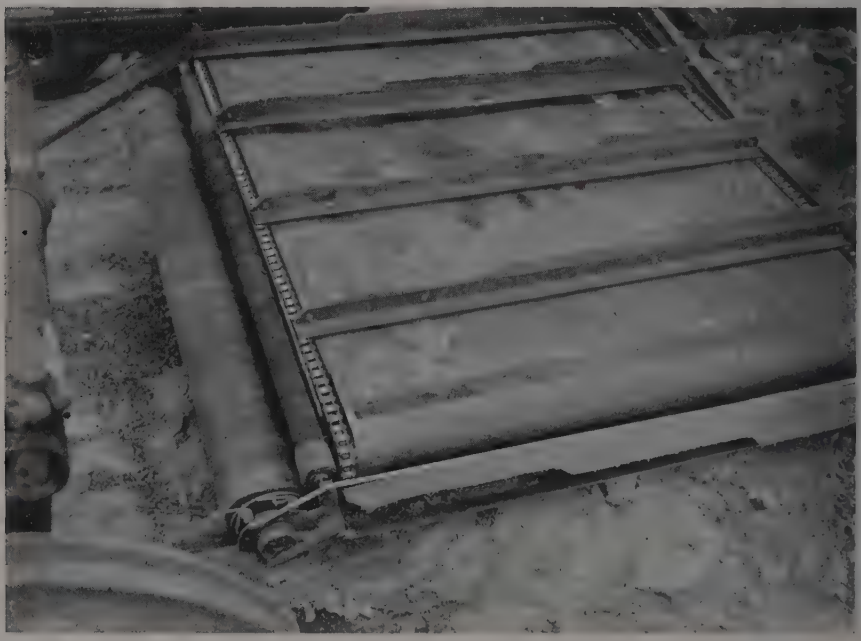

Fig. 11. Pickup and separating bed of Michigan State University experimental cucumber harvester.

hit by a roller or is shaken from the vine onto a belt which carries it to a conveyor and then to a storage unit. The vines drop back onto the ground after passing over the separating bed.

The Michigan State University machine has been described in detail by Leonard[2] in a M.S. degree thesis. Originally this machine consisted of a vacuum pickup device which lifted the vines by the leaves, followed by a flight type separating bed which also served as an elevator to carry the fruit to a storage unit. The separating bed is shown in Fig. 11 along with a later type of pickup device. This device consists of a five-inch sponge rubber roller and a two-inch stripper roller attached to the leading edge of the separating bed. A set of cam operated steel fingers were installed on the end of the five-inch roller nearest the root. The cam mechanism caused the fingers to extend from the roller as they moved upward and to retract after they passed the peak.

Only a few tests were run and no performance data were obtained, but it appeared that the roller and cammed fingers would serve as a satisfactory pickup device. The M.S.U. machine, like the Grew machines, is a "one-way" machine.

A modified Side Delivery Rake was used in 1957 to train the vines to one side of the row. This rake caused excessive damage to the vines and was not an effective trainer.

The Pneumatic Vine Trainer (Fig. 12), developed in 1958, consists of a fan and sheet metal duct which directs a blast of air at the base of the plants. A disc mounted to the rear of the duct provided a small ridge of soil to help hold the vines in place after training. The first training operation was performed just after the vines had started to fall over. The adverse effect of prevailing winds and growth of new laterals made it necessary to go over the field three or four times. Further testing will be necessary, but it appears that the pneumatic vine trainer will provide a satisfactory means of training the vines to one side of the row.

Providing Cucumbers for Testing Purposes

To hasten development of a machine, it was desirable to have vines at as many periods as possible during the year. The normal harvest season in Michigan is from about July 25 to September 10.

[2]Leonard, R. K., 1958. Mechanical Cucumber Harvesting, Unpublished M.S. degree thesis, Mich. State Univ.

Fig. 12. Pneumatic Vine Trainer for blowing vines to one side of the row.

In 1957, normal production practices were followed to provide cucumbers in Michigan and proved unsatisfactory because acceptable plants were available for only a short period of time. Another planting was made in Florida on November 8, but this planting and two successive plantings were lost due to frost or excessive water.

In 1958, plantings were made at the Coastal Plain Vegetable Research Station at Faison, North Carolina. Cucumbers were seeded in bands in a cold frame on March 20 and transplanted April 14. Field seedings were made on April 7, 14 and 21. The banded transplants were lost; however, both the April 7 and 14 seedings were successful and the experimental harvesters were tested during the first week of June.

In 1958, commercial cucumber fields were used for testing the machines at Dansville, Michigan. At East Lansing, fields were available for the experimental harvesters from July 14 to October 3, which was two weeks earlier and three weeks later than commercial plantings in the area.

To obtain this latitude of harvest period, 2000 bands were seeded in the greenhouse, and transplanted in the field on June 2. In addition, field plantings of about ¼ acre were made on June 5, July 2,

and August 1. The late plantings were protected from frost by covering the rows with 4 mil. clear plastic hoods (Fig. 13). The hoods were protected from wind by use of snow fence. The day temperatures were reduced by moving air under the hoods with a centrifugal fan. The big disadvantage of using the plastic hoods was the problem of covering the cucumbers after using the harvesters, and pollinating the fruit under the hoods. Several hundred house fly larvae were placed under the hoods, but these did not seem to be effective probably because of the cold nights and the desire of the flies to escape.

Fig. 13. Plastic hoods for protecting cucumbers from frost.

Performance of Machines

The Grew Belt machine was tested in 1957 on a five-acre plot at Mason, Michigan. The modified side delivery rake was used to train the vines mechanically. After each harvest with a machine, all fruit remaining on the vines or knocked on the ground was collected. Table 1 gives the results of the 1957 tests with the Grew Belt machine.

The efficiency of the Grew Belt machine during 1957 was calculated by comparing the value of fruit machine-harvested to that hand-harvested. Thus, \$9.17/27.35 = 33.5 percent.

TABLE 1—Season performance of Grew Belt machine, 1957

Grade	Weight machine harvested, lb.(a)	Value, $/lb.	Value of machine harvested fruit	Total weight, hand harvested, lb.	Value of hand harvested fruit
No. 1	74.25	$.05	$3.71	170.75	$8.54
No. 2	148.00	.02	2.96	487.50	9.75
No. 3	250.25	.01	2.50	907.50	9.07
Oversize	213.75				
Broken	66.75				
Total			$9.17		$27.35

(a) Total of six harvests during the period from Aug. 9 to Sept. 18.

The Grew Roller machine was rebuilt during the 1957 season, but was available for limited testing. Arrangements for testing the Chisholm-Ryder machine were not completed until late in the season. Table 2 gives the results of the 1957 tests with the Grew Roller and Chisholm-Ryder machines. No directly comparable hand-harvest data are available.

After analyzing the 1957 results the Grew Belt machine was dropped from the testing program. The principal reason was excessive fruit and vine damage by the rubber belts. The Grew Roller and Chisholm-Ryder machines remained in the testing program for 1958. In addition, the M.S.U. machine was constructed in order to test several new pickup and fruit removal principles.

TABLE 2—Field data from separate experiments for Grew Roller and Chisholm-Ryder machines, 1957

Grade	Weight machine harvested, lb(a)	
	Grew Roller	Chisholm-Ryder
No. 1	23	34
No. 2	30	72
No. 3	48	172
Oversize	2	151
Broken	5	8

(a) Total of three harvests for each machine during the period from August 26 to September 18.

After crop failures in Florida, the Grew Roller and Chisholm-Ryder machines were tested in North Carolina early in June, 1958. All machines tested required a mechanical device for removing fruit set near the base of the plant. Several devices were tested on the Grew Belt machine in North Carolina. These included three types of rotating brushes, a rubber beater, and four types of reels made with steel rods located either above or below the plant near its base. Tests with the Chisholm-Ryder machine included the first field operation using new pickup noses (Fig. 9) and the use of various field crops for marking the center of the row. No performance data were collected, but many observations were made which resulted in revisions in the machines before the harvest season in Michigan.

The 1958 tests in Michigan were conducted in a somewhat different manner than those in 1957. It was expected that the machines would be revised many times during the season so no attempt was made to obtain overall season performance. After each test all fruit within 6 inches of the base of the plant was hand-picked. The efficiency was calculated by comparing the value of fruit harvested by machine to the total harvested.

The Grew Roller machine was used throughout the 1958 season to test mechanical devices for removing fruit from the base of the plant. An overhead chain mechanism was developed which was very effective in removing the fruit, but damaged the vines excessively. The results of the tests with the Grew Roller machine are given in Table 3. Observations were made on August 8 and 18 but complete performance data were not collected.

The results of tests with the Chisholm-Ryder machine are shown in Table 4. Although it is a "two-way" machine it was tested on some trained rows. The pneumatic vine trainer reduced the number of laterals growing along the row which in turn reduced the number of inaccessible fruits. However, the data of Table 4 do not show a consistent increase in performance when operating the Chisholm-

TABLE 3—Performance of Grew Roller machine, 1958

Date	Machine efficiency, percent
July 31	21.2
August 29	48.2
August 29	64.8

TABLE 4—Performance of Chisholm-Ryder machine, 1958

Date	Vine position	Machine efficiency, percent
July 30	Trained	41.8
	Untrained	29.8
July 31	Trained	25.4
	Untrained	41.3
August 5	Trained	43.6
	Untrained	42.7
	Untrained	41.1

Ryder machine on trained rows. A test on October 1 with the latest type pickup device and separating bed (Fig. 10) showed an efficiency of 79 percent based on the number of fruit harvested.

Cultural Problems

Row Markers: Experience during the 1957 season indicated that one of the problems with the Chisholm-Ryder machine was following the row during harvest. The clearance on this machine is about 12 inches, and after the cucumbers start to vine it is difficult to see the center of the row, particularly in a good field of cucumbers.

It was believed that the best method of marking the row would be to mix the seed of an upright-growing crop with the cucumber seed. Flax, millet, sweet sudan, buckwheat, sunflower, and oats were tested both in North Carolina and Michigan. A Planet Junior vegetable seeder, which feeds by gravity through the bottom of the hopper, was used. Different ratios of marker crop to cucumber seed were also tried.

The best marker crop tested was Clinton oats at a raito of about 20 parts of cucumber seed to 1 part oat seed by volume. Oats have the most upright growth, will not become a weed pest, are approximately the size of cucumber seed, and mix well with cucumber seed. Flax and millet seed were too small and sifted to the bottom of the hopper. In addition, they did not mark the row as well as oats. Sunflower seeds were too large and produced excessively large plants. Sweet sudan could become a serious weed pest, and grew too large by the

end of the season. Buckwheat branched and lodged so badly that the middle of the row could not be found.

A test was made with a Cole planter which has two hoppers for each row. Oats were used in one hopper and cucumbers in the other. In the hopper with oats, all of the holes in the plate except one were plugged with masking tape. This system dropped one or two oat seeds about every six feet, and appeared to be practical for commercial plantings.

Row Spacing for Mechanical Harvesting

All of the experimental harvesters used to date have required a spacing of 6 to 7 feet between rows. A test was set up to compare yields with different spacings between rows to determine whether or not this wider-than-average spacing would decrease yields. Other research during a four-year period has shown that spacing plants 6 to 12 inches apart in rows 4 and 5 feet wide has increased both early and total cucumber yields compared with spacings as far as 24 inches apart in the row.[3]

The variety, Wisconsin SMR-12, was seeded June 5 on a Wauseon sandy loam in rows 40, 60 and 80 inches apart. Spacings in the row of 6 and 18 inches were also included for each row width.

The test was designed as a split plot with three replications. The main plots were row widths; the sub-plots were the spacings in the row. There were unharvested guard rows between each row width to assure no border effect. The harvested plots were each 40 feet long.

The yield records and plant population for each spacing are presented in Table 5. The 40 inch spacing between rows gave higher yields than either of the other spacings regardless of the spacing in the row. Close spacing in the row did not make up the difference due to wider spacings between rows, and yield was not proportional to the plant population. The total yield from 8,700 plants in rows 40 inches wide with plants 18 inches apart in the row was 568 bushels and the yield from 13,100 plants in rows 80 inches wide with plants 6 inches apart in the row was only 338 bushels. The early yield was higher with the close spacing in the row in all three spacings between rows, but the late yield was lower with the close spacing in the row except with the 80-inch width.

[3]Ries, S. K., 1957. The effect of spacing and supplemental fertilizer applications on the yield pickling cucumbers. M.A.E.S.Q.B., Vol 40, No 2, pp 375-381.

TABLE 5—Yield of pickling cucumbers from various spacings in and between rows (Variety Wisconsin SMR-12)

Spacing in inches		Plant population per acre	Yield (bu. per acre)		
Between rows	In rows		Early (harvests 1-6)	Late (harvests 7-12)	Total
40	6	26,100	314	243	557
40	18	8,700	268	300	568
				Average	562
60	6	17,400	194	198	392
60	18	5,800	170	220	390
				Average	391
80	6	13,100	145	193	338
80	18	4,400	132	164	296
				Average	317
L.S.D. at 5% level					56
L.S.D. at 1% level					93

The result of this first test comparing distances between rows indicates that a maximum effort should be made to produce a harvester that can harvest rows spaced as close as 40 inches.

Control of Fruit Set

A major problem in the development of cucumber harvesters tested to date is the inability to remove fruit set within 6 inches of the base of the plant. It is necessary to remove all of this fruit, because the maturation of only one fruit will delay the production of new blossoms.[4]

It would be desirable to remove this fruit by mechanical means; however, since this proved to be difficult, an attempt was made to find a chemical which would either delay flowering or remove the early fruit set.

During 1957, 2,4-D, 2,4-5-T, amitrol, CIPC, NPA, MH, DNBP[5], Napthalene acetic acid, N-P-cholorphenylphthalamic acid, tris-2-4 dichlorophenoxyethyl phosphite, and gibberellic acid were applied to cucumber plants at several stages of growth in the field and greenhouse to determine their effect on the flowering behavior. All except gibberellic acid either injured the cucumber plants or had no effect on growth or flowering. Gibberellic acid applied at concentrations

[4]McCollum, John P. (June, 1934). Vegetative and reproductive responses associated with fruit development in the cucumber. Cornell Univ. Agr. Expt. Sta. Memoir 163, 27 pp.
[5]The preceding are common names accepted by the Weed Society of America.

of 100 to 1000 p.p.m. proved effective in preventing pistillate flower development at the base of the plant.

The results of one test are presented in Table 6. Applications of 100 and 250 p.p.m. of gibberellin after 2 to 4 true leaves developed were most effective in preventing fruit set at least 7 inches from the base of the plant. Fruit this distance from the base of the plant can be harvested by the machines.

TABLE 6—The effect of gibberellic acid on flowering of pickling cucumbers (Wisc. SMR-12) seeded June 3, 1958 at East Lansing, Michigan (Average of 4 replications)

Treatment conc. p.p.m.	Number of applications	Number of true leaves at time of treatment	Number of nodes to first fruit on primary stem	Distances to first fruit on primary stem (inches)	Distance to first fruit on a lateral (inches)	Yield (bushels per acre)
00.....	....	....	11	23	4.1	407
100.....	1	2–4	17	41	8.2	307
100.....	2	2–4	17	39	8.4	341
100.....	1	5–7	11	24	4.2	
100.....	2	5–7	11	23	5.0	
100.....	1	8–10	12	26	3.7	
100.....	2	8–10	12	24	4.7	
250.....	1	2–4	17	39	7.1	376
250.....	1	5–7	12	24	4.0	
250.....	1	8–10	12	26	4.6	
L.S.D. at 5%.....			2	4	.5	N.S.
L.S.D. at 1%.....			3	5	.7	N.S.
Coefficient of Variation (percent).			12	21	7	19

Furthermore, it was noted that many of the early fruits set occurred on the lateral stems. Gibberellic acid was effective in delaying flower initiation on the primary stem, and increased the distance to the first fruit on the lateral stem. This increased distance was attributed to longer internodes produced following treatment with gibberellin. Fig. 14 shows a comparison between the check and 100 p.p.m. of gibberellin applied at the 2 to 4 leaf stage and illustrates how the gibberellin delayed fruit set near the base of the plant.

Yields were taken from the check and the three treatments that looked most promising. There was considerable variation between these treatments due to water damage so that none of the differences in yield were statistically significant.

Fig. 14. Effect of 100 p.p.m. of gibberellin applied at the 2 to 4 leaf stage (right); check (left). Compare the distance from the base of the plant to the first fruit on each plant.

Gibberellin treatments applied at the same stage of plant development and concentration in late summer (August 18) were not effective in delaying fruit set. This is probably due to environmental factors which will need to be determined before this type of treatment will be practical.

SUMMARY AND CONCLUSIONS

Five experimental cucumber harvesters and two vine trainers were tested during 1957 and 1958. The effectiveness of mechanical harvesting was compared with hand-harvesting, but no attempt was made to determine the economic feasibility of any machine. A number of cultural problems related to mechanical harvesting of cucumbers were investigated. The following conclusions were reached:

1. The efficiency of the Grew Belt machine for the entire 1957 season was 34 percent, the Grew Roller machine in 1958 up to 65 percent and the Chisholm-Ryder machine in 1958 up to 79 percent.
2. Both the "one-way" and "two-way" cucumber harvesters have shown promise. Both systems may need to be developed to fill the widely varying needs of cucumber growers.

3. The Chisholm-Ryder, Grew Belt, and M.S.U. machines have shown good performance during part of the tests, but have not been consistent. All the machines must be made more flexible so that they will perform well under a wider variety of conditions which are expected in general field operation. The Grew Belt and Craig machines were dropped because of excessive damage to the fruit and vines.
4. The pneumatic vine trainer provided a satisfactory means of training the vines to one side of the row for harvest by the "one-way" machines.
5. A major problem with all the machines is the inability to harvest the fruit set within approximately 6 inches of the base of the plant.
6. Gibberellic acid was the most effective chemical tested in preventing pistillate flower development near the base of the plant. The application of 100 and 250 p.p.m. of gibberellin at the 2 to 4 leaf stage were the most effective treatments; however, this was not consistent, probably because of variations in temperature and day length at time of treatment.
7. Oat plants spaced 8 to 12 feet apart along the row provide a satisfactory means of following the row. The Cole dual planter with special plates may be a good planter for planting both cucumbers and oats at the same time.
8. The 1958 results indicate that yields are seriously reduced as the spacing between rows is increased from 40 to 60 or 80 inches. Closer spacing in the row did not overcome this decrease in yield. An effort should be made to produce a harvester that can harvest rows spaced as close as 40 inches.

ACKNOWLEDGMENTS

Stewart M. Craig, Manawa, Wisconsin, inventor of the "Craig" machine.

Dolphus Grew, Saginaw, Michigan, inventor of the "Grew Belt" and the "Grew Roller" machines. (Patent No. 2,841,947)

Lloyd Gilbert, Ravenna, Michigan, inventor of the "Chisholm-Ryder" machine. (Patent No. 2,829,484)

Ike Pierson, Ravenna, Michigan, contributed financial support for the "Chisholm-Ryder" machine during the early years of development.

Chisholm-Ryder, Inc., Niagara Falls, N.Y., merchandiser of "Chisholm-Ryder" machine.

Fox Brothers Machine Company, Bryan, Ohio, manufacturer of "Chisholm-Ryder" machine.

M.S.U. personnel

Ronald K. Leonard and W. F. Buchele, inventors of vacuum pickup and flight type separating bed.

George Bingley, Wayne Beckwith and Fred Bakker, student assistants.

M. J. Bukovac and J. P. Shugars, cooperated on the work on fruit set.

H. W. Madison Company, Mason, Michigan, supplied fields of cucumbers for testing the machines and labor for harvesting the check plots.

N. C. Hayslip, University of Florida, Indian River Field Laboratory, Fort Pierce, arranged for cucumber plots in Florida.

W. W. Reid, and A. A. Banadyga, North Carolina State College, Coastal Plain Vegetable Research Station, Faison, North Carolina, provided cucumber plots in North Carolina.

HERRINGBONE AND OTHER MILKING SYSTEMS

OPERATIONS AND INVESTMENTS

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WHAT ARE THE COMPARATIVE INVESTMENTS in herringbone and other milking systems? How efficient are the different milking systems in the use of labor? What size of milking system should I buy for my farm? These are but a few questions which prompted the Departments of Agricultural Economics, Agricultural Engineering and Dairy to study the herringbone and other milking systems.

The herringbone milking system was developed in New Zealand several years ago. The first one constructed in the United States in the early part of 1957 was patterned after the double 8 system used in New Zealand. In Michigan, the first herringbone milking system, a double 6, was completed in November, 1957. It is estimated that by the end of 1958, there were at least 80 herringbone systems in Michigan either in operation or in some stage of construction.

The trend toward loose-housing, mechanical feeding of forages and improved milking systems makes it possible for one man to handle more cows. Greater investments in bulk tanks and other dairy equipment resulting from changes to bulk milk handling and grade A requirements have also encouraged dairymen to enlarge dairy operations. Increased cost of hired labor stresses the need for making more effective use of labor.

It is important that dairy farmers select the milking system that best fits their individual farm needs. Dairymen need to consider future as well as present herd size and labor force in planning their milking systems.

[1]Bernard Brown and Dean Tribby did most of the field work. The authors gratefully acknowledge helpful suggestions and investment data from B. Edwin Stout of Babson Bros. Co., Ted Cutter of Chore-Boy Milker Sales and John W. May of Clay Equipment Corporation. The authors also wish to express their appreciation to the dairy farmers who cooperated in the study.

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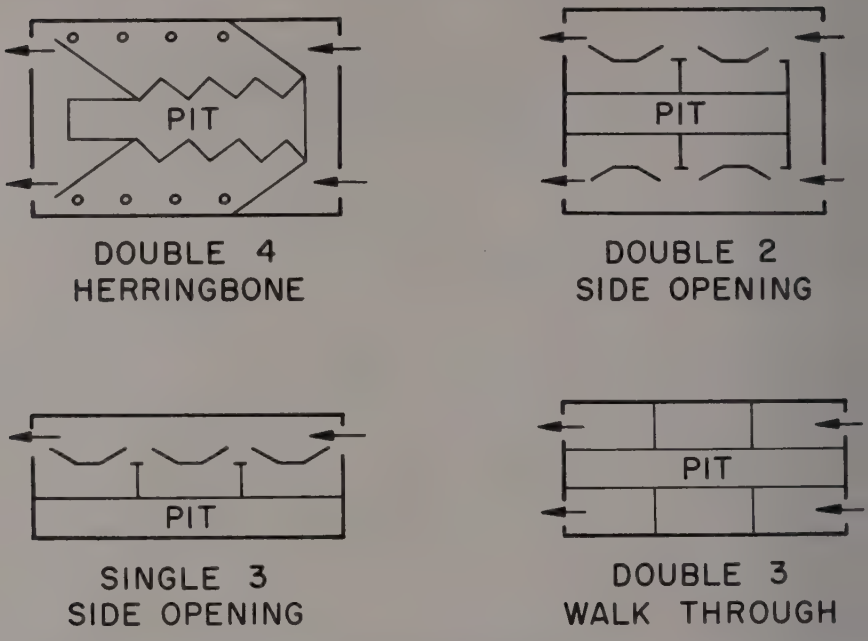

Fig. 1. These four sketches show the general arrangement of stalls and movement of cows through the various milking rooms discussed in this article.

During 1958, information was obtained from 55 dairy farmers who had installed new milking systems. Thirty-three were new herringbone systems and 22 represented various types of other milking parlors.

The 55 dairy farmers provided detailed information on dairy cow numbers, their labor force, and the cost of new buildings, concrete yards, stalls, feeders, milking equipment, bulk tanks, water heaters, room heaters, water softeners and other equipment used in the milking plant. Scale drawings were made showing the location of new milking and milk room buildings, loose-housing barns, and hay and silage feeding areas.

A study of dairy chore operations on farms represented by the different milking systems will be reported in a later publication. Time studies were made of the elements making up a complete milking routine. Detailed information was also obtained on the time required to assemble and clean milking and milk room equipment, to clean the building and perform other dairy operations.

The Herringbone System

In this report, a herringbone system with 6 stalls on each side will be referred to as a double 6 herringbone. Likewise, systems with 4 stalls and 5 stalls on each side will be designated as double 4 and double 5 herringbones. See Fig. 1 for arrangement of different milking systems.

Of the 33 herringbone milking systems studied, one was a double 8, 21 were double 6's, nine were double 4's and double 5's, and the other two were a single 4 and a single 6. Only during the last few months of 1958 did Michigan dairy farmers start building the double 4 and double 5 herringbone systems.

Organization of the farms

Information on the acres operated, number of cows milked and the labor force are shown in Table 1 for 19 farms with 12-stall herringbone milking systems. These dairymen were operating larger than

TABLE 1—Acres operated, number of cows milked and labor force, 19 farms with double 6 herringbone milking systems

Type of construction	Tillable acres operated	Number of cows			Number of men milking(*a*)	Months labor, 1958		
		Before change	1958	Expected 5 years		Operator and family	Hired	Total
A. New building, all work contracted								
Farm No. 1	298	30	70	100	1	15	3	18
2	150	16	40	80	1	24	..	24
3	300	16	80	125	2	36	..	36
4	240	24	26	60	1	15	6	21
5	201	30	40	60	1	21	9	30
6	474	50	106	120	2	12	25	37
7	400	23	140	200	2	18	30	48
8	240	50	69	100	2	15	15	30
9	510	50	88	150	2	3	36	39
10	380	42	100	150	2	..	48	48
B. New building, mostly farmer built								
11	200	50	59	125	1, 2(*b*)	36	1	37
12	300	25	75	100	1	24	6	30
13	260	30	55	80	1	25	..	25
14	420	50	83	100	1	42	..	42
C. Built inside existing building								
15	180	35	35	60	1	21	3	24
16	410	28	45	70	1	24	6	30
17	680	48	90	200	2	16	24	40
18	370	35	54	60	1, 2(*b*)	16	12	28
19	220	40	45	60	2	24	..	24

(*a*) When 2 men work together in the pit, milking with 6 milker units, their division of work is quite variable.
(*b*) Two milk in the morning and one in the evening.

average farms and during the latter part of 1958 were milking from 35 to 140 cows per farm. One-half of the dairy farmers had doubled the number of cows milked since installing the herringbone systems. Eleven of these dairy farmers will be milking from 100 to 200 cows in 5 years if their plans materialize.

The 19 dairymen during 1958 had a labor force totalling from 18 to 48 months. Most of these dairymen will average 40 to 50 cows for each man equivalent of labor used when they attain the cow numbers expected in 5 years.

The double 6 herringbone system is usually rated as a 1-man operation, yet 8 of the 19 dairymen used 2 men, or a man and a boy in the milking pit. Several of these dairymen indicated that 6 milkers were too many units for one man to handle alone and too few to keep two men busy. An Indiana study indicates that one man can milk almost as many cows with 4 as with 5 or 6 milker units.[2] Correspondence with a Farm Economics Research Division, U.S.D.A., researcher indicates his tentative conclusion that 4 or 5 milkers are the best when using a herringbone.[3]

Operation of equipment

The stalls and feeders used on the 19 farms were manufactured by two companies. Ten of the feeders were of the gravity type and 9 were mechanically operated auger feeders. Several of the dairymen experienced considerable operational difficulty with the auger feeders during the fall and early winter when high-moisture, new-crop corn was fed. Two dairymen using outside metal storage bins spent much time in moving grain through the mechanical feeders. The feeders on 18 of the 19 farms were operated from central panels. Doors to let cows in and out were operated by using ropes or pneumatic valves conveniently located in the milking pit.

In general, the 19 dairymen were satisfied with the performance of the milking equipment. Occasionally, a dairyman experienced insufficient vacuum which caused some idle machine time. All of the farms had pipe-line milkers and bulk tanks.

On a few farms, the operators suggested improvements in their herringbone buildings. On two farms, the operating pit was only 32 inches between the curbing. A desirable width ranges from 42 inches

[2]Morris, W. H. M., and E. C. Vestergaard (1958). What to expect from the herringbone milking system. Journal paper No. 1370 of the Purdue Agr. Expt. Sta.
[3]Lindsey, M. M. (1958) unpublished data, Farm Econ. Res. Div., U.S.D.A.

to 50 inches. Location of the end feeder or stall often allowed insufficient or too much space to a wall. When cows must turn to leave the stall, more space is needed than if cows walk directly ahead to an exit door. Two dairymen already recognized that the milk room was inadequate for a larger bulk tank needed at some future date.

Investments in Buildings and Equipment

Buildings constructed to house the double 6 herringbone milking systems on the 19 farms studied varied considerably in design, material used and cost of construction (See Fig. 2). All of the construction work on 10 farms was contracted. Seven of these were of concrete block construction, one was of glazed tile both inside and outside, and two were flat-roofed, prefabricated structures (Table 2).

Cost of all material and labor for the concrete block buildings ranged from $4.00 to $6.70 per square foot of floor area. Three of the concrete block buildings included a glazed surface on part or all of the interior walls. This increased costs from $200 to $500 but added greatly to the appearance and ease in cleaning the interior walls. The prefabricated buildings cost more per square foot and did not provide space for grain storage.

Fig. 2. A well-designed, double 6 herringbone building. This building provides ample space in the milk room for a larger bulk tank if it is needed and convenient storage of grain mixture on the second floor.

Four of the 19 dairymen did most of the construction work and thereby reduced cash costs by $1,200 to $1,800 per farm. Five dairymen built double 6 herringbone systems inside existing barns or sheds. The cost of adapting these buildings to a herringbone system was usually 50 percent or less than for a new building. One dairyman spent as much in remodelling as the cost of a new building.

Cost of milking room equipment for most of the 19 farms ranged from $3,400 to $5,400 (Table 2). The wide variation in costs was due largely to differences in types of feeders and milking equipment used. Mechanical auger grain feeding equipment added $300 or more to investment over gravity type of feeders.

Milking systems equipped with automatic line or tank washers, or pyrex weight jars added to investments. There were also some differences in cost of different brands of equipment. Differences in

TABLE 2—Design of building, and investment in building, and milking room and milk room equipment, 19 farms with double 6 herringbone milking systems

Type of construction	Design and material in building	Size of building	Investment in:			
			Building(a)	Milking room equipment	Milk room equipment	Total
		Sq. ft.	Dollars	Dollars	Dollars	Dollars
A. New building, all work contracted						
Farm No. 1	Conc. block(b)	780	5,254	4,867	3,943	14,064
2	Conc. block	840	4,354	3,881	4,190	12,425
3	Conc. block	972	3,820	5,220	5,429	14,469
4	Conc. block(b)	900	3,840	5,100	3,010	11,950
5	Conc. block(b)	714	3,700	3,650	3,245	10,595
6	Conc. block	1,036	5,627	5,396	3,500	14,523
7	Conc. block	1,080	5,600	4,850	5,775	16,225
8	Prefab, aluminum	739	5,750	4,400	3,120	13,270
9	Prefab, masonite	988	6,050	3,400	5,275	14,725
10	Glazed tile	864	10,200	4,000	3,301	17,501
B. New building, mostly farmer built						
11	Conc. block	980	2,543	4,045	3,768	10,356
12	Conc. block	980	2,335	6,300	6,015	14,650
13	Conc. block	714	3,302	3,901	3,727	10,930
14	Conc. block(b)	792	2,995	3,410	3,125	9,530
C. Built inside existing building						
15	Inside barn	779	2,619	3,740	2,310	8,669
16	Inside barn	806	2,036	3,468	3,280	8,784
17	Inside barn	863	4,869	4,670	2,900	12,439
18	Inside barn	776	1,465	4,400	3,060	8,925
19	Wood frame shed	777	937	3,100	2,474	6,511

(a) Includes all hired labor and material for site preparation, foundation, concrete inside building, lumber, hardware, electrical installation and fixtures, water and sewage installation. Cost of new wells is not included.
(b) Glazed surface on interior walls.

cost of equipment were also affected by discount to the first dairyman in an area using this equipment.

The bulk tank was the major cost item in milk room equipment, adding from $1,800 to $5,300 to investment. These tanks ranged in capacity from 300 to 1,000 gallons. Several of these would be inadequate in capacity when herd size was increased to the numbers expected.

Investment in the double 6 herringbone building, and milking room and milk room equipment totalled from $12,000 to $14,000 when all work was contracted and the building constructed of concrete blocks.

Several of the dairy farms studied had inadequate quantity and pressure in their water systems. Large quantities of water and adequate pressures are needed in cleaning milking equipment, and the milking and milk rooms.

Several of the dairymen transferred water and room heaters from their previous milking set-ups to the new herringbone buildings. Some of these heaters were inadequate for the large installations. The more satisfactory type of heaters cost from $170 to $700. The higher priced ones were combination furnaces and water heaters. The cost of operation should be considered when selecting a new heating system.

Selecting Alternative Milking Systems

Dairymen need to consider many factors in selecting milking systems best adapted to their individual farms. The press and manufactures of herringbone milking equipment have stressed the spectacular accomplishments of one man milking 50 to 60 cows per hour. Since good hired labor is difficult to find and costly it is desirable that labor be used effectively, but factors other than speed in milking are also important. Good milking practices are essential for both quantity and quality of milk.

When one man milks as many as 50 or more cows per hour, there is a tendency to handle all cows alike and to eliminate some of the milking steps recommended by many authorities.[4] To date, we have no research results showing the effect on milk production when cows are handled in batches rather than as individuals. Some dairymen have recently installed walk-through or side-opening rather than

[4]Henderson, H. O. and P. M. Reaves (1954). Dairy cattle feeding and management, 4th Ed. Wiley and Sons. Peterson, W. E. (1950) Dairy science. 2nd Ed. Lippincott Company. Turner, C. W., Harvesting your milk crop. The Surge News, Winter 1954-55.

herringbone stalls because they were uncertain about the results of handling cows in batches.

It is certain that the number of minutes an individual milks cows continuously has an effect on the milk yield per cow. Several of the 54 individual dairymen interviewed indicated that their ability to do a good job of milking declined after they had milked cows for more than 1½ to 2 hours.

Adaptation to Different Sizes of Herds

The dairyman who expects to milk no more than 30 to 40 cows is not limited in the choice of a milking system. He might select a double 3 walk through parlor (Fig. 3) in which the milking operation could be performed by one man in about an hour's time (Table 3). The single 3 side opening using three milker units, or the single 4 and double 2 side opening stalls using four milker units would permit one man to milk 40 cows in 70 to 100 minutes. The performance for the 3-stall U, the 4-stall U or the double 2 side opening parlor would

Fig. 3. The double 3 walk-through milking system approaches the double 4 herringbone system in milking time. Several of the dairymen included in the study milked as many as 30 to 40 cows per hour using this system.

TABLE 3—Estimated herd size and milking performance associated with herringbone and other milking systems using good milking practices

Milking system and number of stalls	System adapted to herds of:	Milker units used	Men milking	Average number of cows milked per hour	Average number of cows milked per man hour
	Number of cows	Number	Number		
Herringbone					
Double 4	40–80	4	1	35–45	35–45
Double 5	60 & over	5	1	40–50	40–50
Double 6	70 & over	6	1(*a*)	42–52	42–52
Double 6	70 & over	6	2(*b*)	47–63	23–32
Double 8	100 & over	8	2	70–80	35–40
Walk-through					
Double 3	30–70	3	1	30–40	30–40
Double 4	40–80	4	2(*b*)	40–50	20–25
U Parlor					
3 stall	20–60	3	1	25–35	25–35
4 stall	20–60	4	1	25–35	25–35
Side opening					
Three in line	20–40	3	1	20–30	20–30
Four in line	20–50	4	1	20–35	20–35
Double 2	25–50	4	1	25–35	25–35
Double 3	40–80	6	2(*c*)	40–60	20–30
Double 4	60 & over	8	2(*c*)	40–70	20–35

(*a*) Requires one milker of exceptional milking skill and judgment to operate this system.
(*b*) When 2 men work as a team in the milking pit, using 6 to 8 milking units, the division of the work is quite variable.
(*c*) With the double 3 and double 4 side opening stalls, one man usually operates each side independently.

be slightly faster due to a shorter walking distance. A dairyman with 40 cows could milk them in an hour or less in a double 4 herringbone milking room.

The choice of a system for the dairyman with 50 to 60 cows may be determined quite largely by his labor force, including family labor. The 50 to 60 cow dairyman who must milk with only one man could use the same systems as the dairymen with 30 or 40 cows but he would spend two hours or more milking if he used side-opening stalls. For 60 cows, he could do the milking in 1½ to 2 hours if he used a double 3 walk through and in 1¼ to 1½ hours if he used a double 4 or double 5 herringbone (Fig. 4).

A few Michigan dairymen have installed double 4 walk through, and double 3 and double 4 side opening parlors (Fig. 5). These are

usually operated by two men in the milking pit. The number of cows milked per hour is estimated as 40 to 50 for the double 4 walk through, using four milkers and as 40 to 60 for the double 3-side opening system using six milker units. With a double 4-side opening parlor and 8 milker units, two men could milk 50 to 70 cows per hour. Two men using these 3 types of parlors could milk upwards of 80 to 90 cows in 1½ to 2½ hours time (Table 3).

It is expected that the herringbone milking system will have its greatest appeal to dairymen milking more than 40 cows. A good milker can handle 4 or 5 milker units and should have no difficulty in milking 40 to 50 cows an hour. Timing of milking operations in double 6 herringbone systems showed only one man milking as many as 55 cows per hour. In this case, three men alternate, milking one week at a time.

Dairymen must also consider the time spent in assembling and cleaning the milking and milk room equipment, in cleaning floors and walls of the building and in doing other daily chores associated

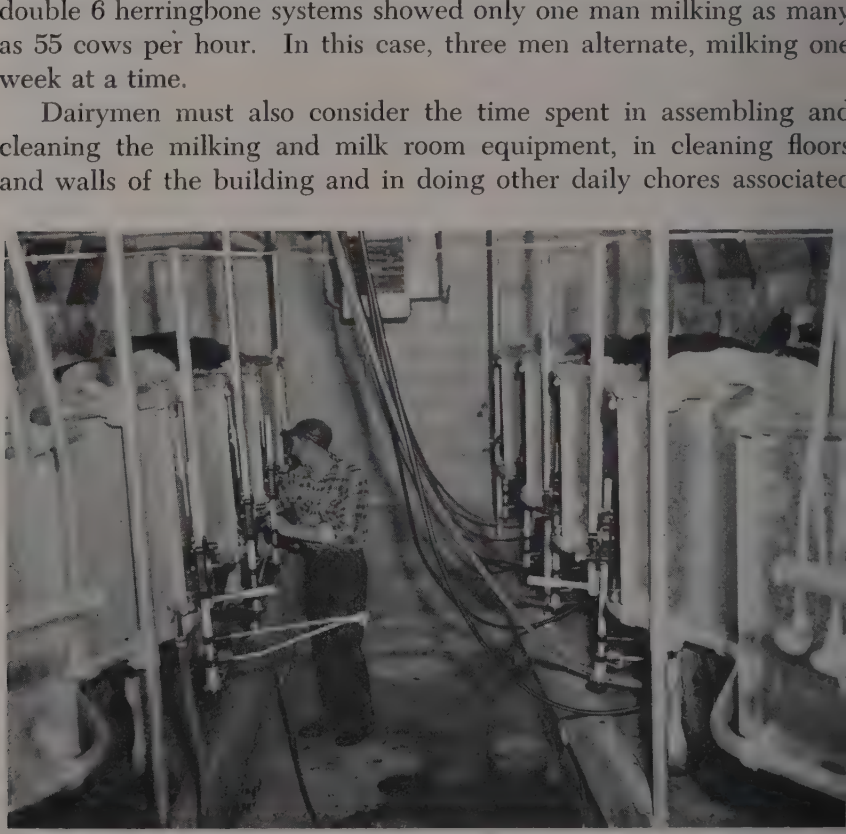

Fig. 4. Physical efforts are minimized in the herringbone milking system because of the short distance between cows' udders. This distance varies from 30 inches to 39 inches. Good performance for one man operating a double 4 or double 5 herringbone milking system is 40 to 50 cows per hour. The exceptional milker can operate a double 6 herringbone system, milking up to 55 cows an hour

Fig. 5. Two men operating this double 3 side-opening milking system can milk 40 to 60 cows per hour. Note glazed walls which are attractive and easy to clean.

with the milking operation. These other chore jobs combined usually take from 50 to more than 90 percent as much time daily as does the chore of milking.

Building Size and Total Investment

The number of square feet of building space needed for the different milking systems is shown in Table 4. The cost of building concrete block buildings has been estimated at $4.25 per square foot. This cost is based on hiring all labor and includes site preparation, foundation, all concrete work in building, concrete blocks, lumber, hardware, electrical installations and fixtures, and water and sewage installations.

Investment in the building suitable for a double 3 walk through, a 3 in line side opening and a 3-stall U is estimated to be about the same. The cost of a building for a double 4 herringbone system

(Fig. 6) is about the same as for a double 4 walk through, a 4 in line side opening and a 4-stall U (Table 4).

The investments in stalls and feeders, and milking equipment for the different milking systems are shown as ranges since different brands differ in type of equipment provided and prices. The investment figures for stalls and feeders are based on using gravity feeders. Auger feeders would add $300 to investments. Stalls and feeders are the least expensive per cow for the herringbone systems and the highest per cow for the side-opening parlors. But the total investment is usually higher for the herringbone because of the greater number of stalls. Many milking systems include automatic pipe-line washers.

These add about $300 to investments but make it possible for the operator to pre-set the cycles and do other work while the

TABLE 4—Investment in herringbone and other milking systems

Milking system and number or stalls	Size of building	Investment in:		
		Building(*a*)	Stalls and feeders(*b*)	Milking equipment(*c*)
	Square feet	Dollars	Dollars	Dollars
Herringbone				
Double 4.....	774	3,290	900–1,100	1,850–2,700
Double 5.....	884	3,757	1,050–1,350	2,150–3,100
Double 6.....	994	4,215	1,200–1,650	2,400–3,500
Double 8.....	1,105	4,696	1,350–1,900	2,650–3,900
Walk-through				
Double 3.....	690	2,932	850– 950	1,900–2,100
Double 4.....	800	3,400	1,100–1,300	2,250–2,300
U parlor				
3 stall.....	640	2,720	650– 750	1,900–2,000
4 stall.....	800	3,400	850–1,000	2,100–2,200
Side opening				
Three in line.....	680	2,890	650– 750	1,900–2,200
Four in line.....	780	3,315	850–1,000	2,200–2,300
Double 2.....	860	3,655	850–1,000	(*d*)1,900–2,200
Double 3.....	1,014	4,310	1,250–1,550	(*d*)2,200–2,600
Double 4.....	1,170	4,972	1,650–2,050	(*d*)2,600–3,000

(*a*) Includes contract price of labor and material for grading, foundation, concrete inside building, lumber hardware, electrical installations and fixtures, water and sewage installations. Add $300 to $500 for cost of glazed interior surface. Cost of new wells or sewage systems constructed are not included.

(*b*) For gravity feeders. Add $300 for extra cost of auger feeders.

(*c*) Most of these systems include either automatic or semi-automatic line washers. Pyrex weight jars costing about $137 each, milking meters and automatic tank washers are not included in these investment figures.

(*d*) The double 2, 3, and 4 side opening systems include milkers for each stall.

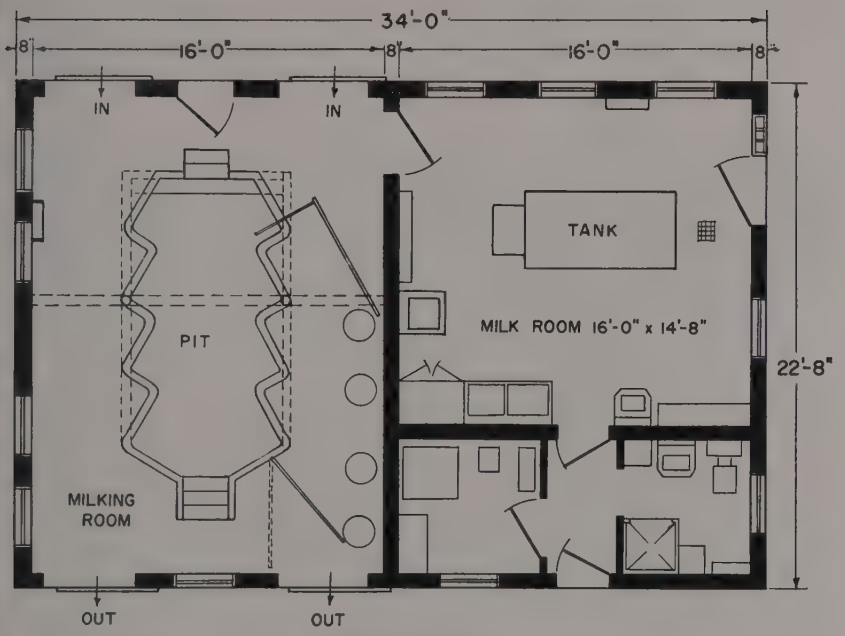

Fig. 6. Floor plan for double 4 herringbone building. This plan can be adapted to double 5 or larger milking rooms by adding 39 inches to the building for each additional stall added. Plan No. 723-C1-70 for this double 4 herringbone building can be obtained from your local county agricultural director or the department of agricultural engineering, Michigan State University, East Lansing, Michigan.

equipment cleans the line and milking equipment and automatically shuts itself off. This investment aids in proper cleaning of equipment. The other milking systems usually include semi-automatic cleaning equipment which also aids in proper cleaning of equipment.

Dairymen need to consider both present and future cow numbers in selecting a bulk tank. The recommended minimum sizes of bulk milk tanks for different quantities of milk produced daily are shown in Table 5.

Systems for Large Dairy Farms

The dairy farmer who expects to milk more than 100 cows and use two or more men to milk, needs to give careful consideration to designing a system that is flexible enough to operate on weekends and other times when the milking force may be reduced. It

TABLE 5—Recommended minimum sizes of bulk milk tanks

Daily peak production	Minimum size of tank	
	Every day pickup	Every other day pickup
Gallons	Gallons	Gallons
120	180	300
160	240	400
200	300	500
240	360	600
280	420	700
320	480	800
360	540	900
400	600	1,000

should also provide the possibility of adding more housing and feeding units and make maximum use of the milking room.

We shall assume that a herringbone milking system will be used on the larger dairy operations. We shall also assume that one man using 5 milker units in a two-sided herringbone milking room can milk up to 100 or 120 cows. He would do no other work than let cows in and out, feed grain, wash cows, assemble and clean milking equipment, and possibly clean the milking and milk rooms. The dairyman with 200 cows has several choices in the manner in which he milks these cows, using two men.

1. He could build a separate milking room for each man with a milk room serving both rooms.
2. He could use one milking room and plan for each milker to handle his 100 cows in separate shifts.
3. He could build a double 8 or a double 10 herringbone building using two milkers in the same milking pit.

It would appear that alternatives 1 and 2 might be the best choice for most dairymen with large herds. This would be particularly true for dairymen hiring both milkers. When two men operate in the same milking pit, performance is often reduced due to conversation between the milkers.

The double 8 or double 10 herringbone system would be a good choice where the operator works with another member of the family

or a hired milker (Fig. 7). When a younger member of the family assisted in the milking, the father would be on hand to supervise the operation.

Fig. 7. The double 8 or double 10 herringbone system is best adapted to farms where 2 members of a family or the operator and a hired man work as a team in the milking pit. Too much visiting might occur when 2 hired milkers operate in the pit.

EXPERIMENTS WITH NEW INSECTICIDES FOR CONTROL OF EUROPEAN PINE SHOOT MOTH[1]

By J. W. BUTCHER and DEAN L. HAYNES

DEPARTMENT OF ENTOMOLOGY

IN A RECENT PAPER the writers briefly reviewed some of the existing literature on use of insecticides for control of European pine shoot moth in intensively managed pine plantations.[2] At that time evidence was presented to show that Phosdrin might have a place in fall control of this insect on pine seedlings.

Earlier work has demonstrated the value of DDT sprays when applied in the spring at the time overwintering larvae resume feeding; and again in the summer when newly hatched larvae begin feeding in needles.[3],[4] Haynes et al[5] have recently shown that certain phosphate compounds may be translocated in insecticidal quantities to parts of the plant where shoot moth feeding takes place.

The main objective of this study was to ascertain the insecticidal properties of available materials when applied to shoot moth infested red pine.

Experimental Method

Plantation grown red pine, *Pinus resinosa* (Ait.) heavily infested by European pine shoot moth was used in all of these experiments. For spring applications made at the Rose Lake Wildlife Experiment

[1]Part of M.S.U. forest insect research program. The cooperation of Michigan Department of Conservation, Division of Forestry, and Rose Lake Wildlife Experiment Station personnel made this study possible. Aid given by the Lake States Forest Experiment Station Lower Peninsula branch in part of this study is gratefully acknowledged. The writers also wish to thank A. A. Wuotila, Vo. Ag. instructor at Buckley and Mesick, Michigan; R. V. Ford, Mesick, Michigan, and Ira Bull, Associate Professor of Forestry, M.S.U. Department of Forestry, for providing facilities and aid when requested.

[2]Butcher, J. W., and Dean Haynes (1958). Fall control of European pine shoot moth on pine seedlings. Mich. Agr. Expt. Sta. Quart. Bul. 41:264-268.

[3]Miller, W. E., and R. B. Neiswander (1955). Biology and control of the European pine shoot moth. Ohio Agr. Expt. Sta. Res. Bul. 760, 31 pp.

[4]Guyer, Gordon, W. F. Morofsky and W. Lemmien (1957). The evaluation of insecticides for control of the European pine shoot moth under spring and summer conditions. Mich. Agr. Expt. Sta. Quart. Bul. 39:236-240.

[5]Haynes, Dean L., Gordon Guyer, and J. W. Butcher (1958). Use of systemic insecticides for the control of the European pine shoot moth infesting red pine. Mich. Agr. Expt. Sta. Quart. Bul. 41:269-278.

ARTICLE 41-76

Station, Bath, Michigan on April 17-19, 1958, trees ranging in height from 3 to 6 feet were used. The contour planted trees in this experiment were arbitrarily divided into 4 blocks, each of which contained trees of approximately uniform size. Each treatment appeared once in each block. The spring treated plots were examined on May 22 for presence of shoot moth larvae. Ten separate, uppermost, two-inch shoot tips were dissected by hand, and total number of live larvae or pupae were recorded per tree and per plot. At this time of the year the larvae were almost full grown and readily visible to the naked eye.

Summer treatments were carried out at Mesick, Michigan, and at the Rose Lake Wildlife Experiment Station. In the summer applications made at Mesick on July 9, 1958, trees averaging 3 to 4 feet in height were used. The planting was rectangular in shape and was divided into 4 two-row blocks. Each treatment appeared once in each block. The summer Rose Lake applications were made on June 24, 1958. The trees were contour planted in rows and averaged 5 to 6 feet in height. Four rows were selected, and each treatment appeared once in each row. In all of these experiments a plot consisted of 5 consecutive trees in a row, and was separated from the succeeding plot by an unmarked, untreated tree. The treatments were randomized within each block.

The chief problem encountered in shoot moth control is one of insuring that an insecticidal residue is present on those portions of the plant likely to be contacted by larvae during the brief period before they enter the plant tissue in early spring or midsummer. The possibility that a spreader-sticker might prolong the residual life of some of the more volatile hydrocarbons or phosphates was suggested by various authors, including Crosby[6]. This worker materially improved the performance of BHC against white pine weevil by adding Aroclor solution to the insecticide mixture. Since many shoot moth control failures are undoubtedly due to poor timing of the application, the writers combined three proprietary spreader-stickers with each of four insecticides used in these experiments. Plyac, manufactured by General Chemical Division, Allied Chemical and Dye Corporation, was added directly to the insecticide-water mixture as shown. DA-70, which was made available by the Diamond Alkali Company; and Aroclor, manufactured by Monsanto Chemical Company, were mixed

[6]Crosby, David (1958). Control of the white-pine weevil with insecticidal emulsions. Northeast Forest Expt. Sta. Forest Res. Note No. 78 4 pp. 1958.

at the rate of 50 parts spreader-sticker and 50 parts xylene by weight. When these were combined with Phosdrin, a water soluable material, and Tetram (75 percent technical), 10 milliliters of Triton X-100 were added to each gallon to get suitable emulsification.

The summer treatments were evaluated by collecting five apparently injured or infested 2-inch shoot tips from the top of each tree. These were taken into the laboratory and dissected under appropriate magnification.

All insecticides were applied with a 2-gallon Lofgren sprayer equipped with a fan-type nozzle. The spray was applied until the foliage was visibly wet, but stopped before dripping occurred.

RESULTS

Spring Treatments—1958

Data in Table 1 show that of the 16 materials used in these tests, 11 reduced the live shoot moth population significantly over that found in the check plots. The control obtained with DDT confirms the findings of earlier workers. Of particular interest were the performances of two American Cyanamid experimental insecticides classed by the manufacturers as members of the "carbamoyl phosphate" group. These were compounds 12880 (O, O-dimethyl S(N-methylcarbamoylmethyl) phosphorodithioate) and 18706 (O, O-dimethyl S(N-ethylcarbamoylmethyl) phosphorodithioate).

At 2 pounds actual insecticide per 100 gallons of water both materials gave control comparable to DDT. In view of their low mammalian toxicity, the performances of Sevin at 4 pounds actual insecticide per 100 gallons of water, and Perthane at the same dosage are noteworthy also.

All of the materials were applied at the time overwintered larvae began spring activity, and only an occasional new pitch mass gave evidence of feeding when the plots were being laid out. By the time spraying took place several days later, spring feeding activity was noticeable on virtually every shoot. This suggests that the spring timing was near optimum for residual or contact insecticides. As a result, it is difficult to assess the reputed "foliar systemic" properties of compounds 12880 and 18706 on the basis of these data. Under such circumstances, control might well be due to contact or fumigant action on exposed larvae. Nevertheless, in view of the manufacturer's belief that these compounds possess significant systemic properties;

TABLE 1—Summary of spring insecticide trials for control of European pine shoot moth—Rose Lake, Michigan. Applications made April 17-19, 1958

Material	Formulation(*a*)	Amt. actual insecticide 100 gal. water	Live larvae found May 22, 1958		Percent reduction from check
			Total number(*b*) in 4 replicates	Mean number(*b*) per plot	
Am. Cyan. 12880.	4 lbs./gal.....	2 lbs.	0	0*	100
DDT.....	3 lbs./gal.....	2 lbs.	5	1.3*	97
Phosdrin.....	2 lbs./gal.....	1 lb.	6	1.5*	97
Am. Cyan. 18706.	2 lbs./gal.....	2 lbs.	9	2.3*	95
Sevin.....	1 lb./gal.....	4 lbs.	12	4.0*	91
Thimet.....	4 lbs./gal.....	2 lbs.	24	6.0*	87
Tetram.....	75% tech.....	0.5 lb.	30	7.5*	84
Perthane.....	4 lbs./gal.....	4 lbs.	40	10.0*	78
BHC.....	2 lbs./gal.....	4 lbs..... (gamma)	65	16.3*	64
Endrin.....	1.6 lbs./gal.....	1 lb.	70	17.5*	62
Diazinon.....	2 lbs./gal.....	1 lb.	89	22.3*	52
Thiodan.....	2 lbs./gal.....	2 lbs.	129	32.3	
Di-syston.....	2 lbs./gal.....	2 lbs.	136	34.0	
Gen. Chem. 1189 (Kepone).....	2 lbs./gal.....	1 lb.	143	35.8	
Heptachlor.....	2 lbs./gal.....	2 lbs.	190	47.5	
Dieldrin.....	1.5 lbs./gal....	1 lb.	227	56.7	
Check.....			186	46.5	

(*a*) American Cyanamid 12880 and 18706 were supplied as "solubilized" concentrates; Phosdrin as a water soluble solution, Tetram a 75% tech. powder and all others as emulsion concentrates.

(*b*) Plot sample was obtained by dissecting the top 10 shoots from each of the 5 trees in a plot. Total of 50 shoots per plot or 200 shoots for 4 replicates.

*Differs significantly from check at 5 percent level applying method described by Snedecor, George W. (1957), *Statistical Methods*, Iowa State Col. Press. Ames, p. 251. (D =24.04).

and equally important, that they are among the less toxic organic phosphate pesticides to handle, the data are of more than passing interest. Further studies are contemplated which would elucidate the mode of action through timing tests, and throw light on the efficacy of reduced dosages or low gallonage equipment.

The excellent results obtained with Phosdrin confirm earlier reports of success with this chemical when the larvae are present on the tree. Phosdrin may have a definite place in fall treatment of seedlings but is not likely to compete with DDT for use on larger trees in view of its high mammalian toxicity and present cost.

It should be made clear that timing in these trials was very near optimum; i.e. even transitory materials like Phosdrin and Tetram were applied at a time when the larvae were most accessible to the

toxicant. Under these conditions little could be gained by prolonging or intensifying the insecticidal action of an already effective material. As a result an analysis of control obtained with the chemicals alone, and in combination with each of the three spreader-stickers shows that, in general, little benefit derived from their use under the conditions of this experiment. (Table 2). This would necessarily be the

TABLE 2—Influence of spreader-stickers on effectiveness of insecticides against European pine shoot moth. Applications made April 17-19, 1958

Material	Formulation	Pounds actual insecticide —100 gal. water	Ml spreader sticker/gal.	Live larvae found May 23, 1958		Percent reduction from check
				Total No. in 4 replicates(*a*)	Mean number per plot(*a*)	
Kepone	2 lbs./gal.	1		143	35.8	
Kepone+Aroclor	2 lbs./gal.	1	19	136	34.0	
Kepone+Plyac	2 lbs./gal.	1	19	77	19.3*	58.5
Kepone+DA-70	2 lbs./gal.	1	19	165	41.3(*b*)	
Tetram	75% tech.	0.5		30	7.5*	83.9
Tetram+Aroclor	75% tech.	0.5	19	16	4.0*	91.4
Tetram+Plyac	75% tech.	0.5	19	24	6.0*	87.1
Tetram+DA-70	75% tech.	0.5	19	2	0.5*	99.0
BHC	2 lbs. gamma/gal.	4 (gamma)		65	16.3*	64.9
BHC+Aroclor	2 lbs. gamma/gal.	4 (gamma)	75	49	12.3*	73.5
BHC+Plyac	2 lbs. gamma/gal.	4 (gamma)	75	133	33.3(*c*)	
BHC+DA-70	2 lbs. gamma/gal.	4 (gamma)	75	93	23.3*	49.9
Phosdrin	2 lbs./gal.	1		6	1.5*	96.8
Phosdrin+Aroclor	2 lbs./gal.	1	19	0	0*	100.0
Phosdrin+Plyac	2 lbs./gal.	1	19	0	0*	100.0
Phosdrin+DA-70	2 lbs./gal.	1	19	21	5.3*	88.6
Check				186	46.5	

*Differs significantly from check at 5% level (D =24.05) applying method described by Snedecor G. W. (1957); op. cit. p. 251.

(*a*) Plot sample was obtained by dissecting the top 10 shoots from each of 5 trees in a plot. Total of 50 shoots per plot or 200 shoots for 4 replicates.

(*b*) Not significantly different from straight Kepone but differs significantly from Kepone-plus-Plyac at 5% level using sequential comparison of means method described by Snedecor, G. W. (1957) Ibid. p. 253, (D =20.70).

(*c*) Not significantly different from straight BHC but differs significantly from BHC-plus-Aroclor at 5% level using a sequential comparison of means method described by Snedecor G. W., (1957) Ibid. p. 253 D =19.60).

case where the population was reduced significantly by the chemical alone, e.g. Tetram, BHC, and Phosdrin, and no striking improvement could have occurred as a result of adding a spreader-sticker. Despite this, when added to Kepone, Plyac materially improved the performance of this insecticide as compared with the check.

The difference between Kepone, plus Plyac and Kepone plus DA-70 was significant also. The inferior control obtained with BHC plus Plyac as compared with BHC alone suggests the possibility of

inhibition or incompatibility. In view of these data the compatibility of most of the spreader-stickers with the insecticide to which they were added is a development worthy of note.

The objective of further research with these materials would be to evaluate their usefulness in prolonging the residual life of available insecticides. This might be accomplished by (1) making applications well in advance of larval accessibility; or (2) incorporating them in low volume applications. In the first instance, timing of the application might be less critical. In the second, by prolonging the life of the toxicant there is an increased likelihood that a foraging larva would contact widely dispersed droplets.

Summer Treatments—1958

The more promising chemicals used in the spring experiments, plus several new materials, were included in summer trials carried out at Rose Lake, on June 24-27, and at Mesick, on July 9. It seems likely that poor control at Rose Lake (Table 3) resulted from premature application, since 30 percent of the eggs were still unhatched at Rose Lake on July 11, approximately two weeks after the applications

TABLE 3—Summary of insecticide trials for control of European pine shoot moth. Rose Lake, Michigan. Applied June 24-27, 1958

Material	Formulation(*a*)	Pounds actual—100 gal. water	Live larvae found(*b*) November, 1958		Percent reduction from check
			Total in 4 replicates	Mean number per plot	
Am. Cyan. 12880.....	4 lbs./gal...	2.0	83	20.8	32.0
Am. Cyan. 12880.....	4 lbs./gal...	0.5	115	28.8	6.5
Phosdrin.....	2 lbs./gal...	0.5	77	19.3	37.0
Am. Cyan. 18706.....	2 lbs./gal...	2.0	100	25.0	19.0
Shell Chem. SD 3562(*c*).	tech.....	1.0	100	25.0	19.0
Shell Chem. SD 4402(*d*).	1 lb./gal....	1.0	94	23.5	24.0
Phosphamidon.....	4 lbs./gal...	1.0	79	19.8	36.0
DDT.....	3 lbs./gal...	2.0	83	20.8	32.0
Check.....			123	30.8	

(*a*) The American Cyanamid Compounds 12880 and 18706 were supplied as "solubilized" concentrates and Phosdrin and Phosphamidon were water soluble concentrates. The SD3562 used was a water soluble technical material, and DDT an emulsion concentrate.

(*b*) None of the treatments differed significantly from the check at the 5% level, based on method described by Snedecor, G. W. op. cit. p. 254.

(*c*) 3-(Dimethoxyphosphinyloxy)-N, N-dimethylcrotonamide.

(*d*) 1, 3, 4, 5, 6, 7, 8-octachloro-3a, 4, 7, 7a-tetrahydro-4, 7-methanophthalan.

were made. In Ohio, Miller and Neiswander (1955)[7] found that the period during which good summer control of shoot moth might be obtained lasted only about 16 days.

The Mesick summer sprays were made on July 9, approximately two weeks later, and showed quite different results (Table 4, A). Here it can be seen that DDT and American Cyanamid 12880, at 2 pounds per 100 gallons, performed well as they had done in the spring trials. A new chlorinated hydrocarbon, Shell Chemical SD4402, gave very good control also at the 1 pound per 100 gallon rate.

Phosdrin, which gave good results in the spring apparently was not present on the plant at levels adequate to kill a significant number

[7]Miller, W. E., and R. B. Neiswander (1955), op. cit.

TABLE 4—Summer insecticide trials—Mesick, Michigan. Comparison of sampling based on (A) live larvae, and (B) infested shoots and including estimate of total shoot moth population in the respective plots (C) Treatments applied July 9, 1958

Material	Formulation lbs./gal.(*a*)	Lbs. actual insecticide/ 100 gal. water	A(*b*) Mean number live larvae/ injured shoots	B(*c*) Percent injured shoots	C(*d*) Mean number live larvae in sample	Percent reduction from check
Am. Cyan. 12880.....	4	2.0	.31*	30.8	10.3*	87
Am. Cyan. 12880.....	4	0.5	1.06	66.6	86.5	0
Am. Cyan. 18706.....	2	2.0	.65	42.4	34.0*	57
Am. Cyan. 18706.....	2	1.0	.86	61.8	66.3	17
Phosdrin.....	2	0.5	.96	47.4	55.3	31
Shell Chem. SD4402.....	1	1.0	.04*	6.4*	0.8*	99
Shell Chem. SD3562.....	tech.	1.0	.98	68.0	82.8	0
Phosphamidon.....	4	1.0	.57*	34.0	21.0*	74
DDT.....	3	2.0	.10*	1.2*	0*	100
Shell Sol. 72(*e*).....			.38*	31.6	15.8*	80
Ortho Corn Oil special(*f*)...			.00*	.8*	0*	100
Bacillus thuringiensis(*g*)....			.82	53.4	50.5	37
Check.....			1.25	51.8	79.5	

*Differs significantly from check at the 5% level using method described by Snedecor, G. W., op. cit. p. 254, D =0.65 (column 'A'); D =39.4 (column 'B'); D =41.21 (column 'C').

(*a*) American Cyanamid Compounds 12880 and 18706, as well as Phosdrin and Phosphamidon were water soluble concentrates. The SD3562 used was water soluble technical material and DDT an emulsion concentrate.

(*b*) Based on number of live larvae in 5 injured shoots per tree; 25 per plot or 100 for the 4 replications. Visible injury (pitch blisters) was interpreted as infestation by shoot moth.

(*c*) Based on 25 shoots per tree; 125 per plot or 500 for the 4 replications.

(*d*) The mean number of live larvae in sample was obtained by multiplying the mean number of live larvae per injured shoot (based on a 5 shoot per tree sample) times the total number of injured shoots counted in the same plot (based on a 25 shoot per tree sample). This estimate was analyzed for significant differences between treatments.

(*e*) An insecticide solvent manufactured by Shell Chemical Co. DDT emulsion concentrate was added at the rate of 2 lbs. actual DDT in 100 gallons of final solution.

(*f*) Contains 1 lb. DDT per gallon and 50% oil by volume, (emulsifiable). Applied without dilution in these experiments.

(*g*) An entomogenous bacterium. The wettable powder used in these experiments had a count of 70 billion spores per gram. It was applied at the rate of 2 grams per gallon. Two ml. of Triton X-100 was added to aid wetting.

of late hatching larvae. The fact that dosage was cut to ½ pound actual insecticide per 100 gallons could have contributed to the lower level of control.

Of possible interest from the standpoint of future efforts to improve low gallonage application effectiveness was the performance of two oil diluents; Shell Sol 72, a Shell Chemical Company product (made available by the Glenn Chemical Co.), and Ortho Corn Oil special, manufactured by the California Spray-Chemical Corporation. In the case of Shell Sol 72, emulsifiable DDT was the only additive.

The Ortho Corn Oil was applied as it came from the shipping container. There was no evidence of discoloration on any of the Shell Sol 72 sprayed trees, but there was pronounced yellowing of the foliage in the Corn Oil plots in September 1958. By late October 1958, the trees, while still somewhat yellow, appeared to be recovering. Further experimentation with both of these materials is planned.

The ease with which oils wet conifer foliage suggests their possible value as carriers in concentrate spray equipment. The Shell Sol 72-DDT, and Ortho Corn Oil formulations gave 80 and 100 percent control, respectively. The corn Oil control figures are meaningless since the DDT concentration was 50 times the recommended control rate, but the possibility that nonphytotoxic formulations of DDT in oil can be worked out is encouraging. *Bacillus thuringiensis* Berl. did not reduce the shoot moth population significantly under these conditions; but the performance of this organism against other Lepidoptera warrants further experimentation, with emphasis on varying the time of application.

Analysis of Summer Sampling Technique

The practice of selecting "apparently infested" 2-inch shoot tips has made it possible to limit the number of dissections necessary in order to measure shoot moth abundance in the respective plots. There was nothing to be gained by looking for shoot moth in shoots that obviously had not been fed upon. However, the differences in population density arrived at through this sampling method are not indicative of total number of shoot moth larvae left in the treated and untreated plots at the time of sampling.

Since the insecticides used vary in their residual, systemic and contact properties, one might be expected to kill quickly, before a shoot shows evidence of feeding. Another might kill much later,

after visible feeding injury has taken place. To throw light on these problems, counts were made of total numbers of injured shoot tips found among the top 25 shoots of each tree in the Mesick summer treatments.

These counts were analyzed statistically to determine whether observed performance of the respective materials was altered by measuring number of shoots injured rather than population per infested shoot. These data are presented in Table 4, column "B", as percent of shoots injured in sample. In columns "A" and "B", Table 4 it will be noted that the number of treatments differing significantly from the check are not the same even though the same statistical analysis was used. It can be concluded that the practice of counting live larvae per five injured shoots per tree is more likely to reflect treatment differences than is a count of number of injured shoots in a 25 shoot per tree sample.

Quite apart from the problem of sampling, it is desirable to know what percentage of a total shoot moth population is killed by an insecticide. Having an estimate of surviving population (column "A") and injured shoots (column "B") it is possible to arrive at an estimate of the population surviving in each plot. In column "C" this is expressed as the mean number of live larvae in sample. In this case the sample is 125 shoots per plot or 500 for the four replicates. When surviving larvae per injured shoot are multiplied by number of injured shoots in the same plot, the product, or mean number per plot differs significantly from the check in seven instances as opposed to six instances in column "A" and three instances in column "B."

Coefficient of variation values were computed for the variance between replications in each of the sampling methods. The values obtained were 3.9 percent for column "C" (mean number of live larvae in sample), 2.9 percent for column "A" (mean number of live larvae per injured shoot) and 1.6 percent for column "B" (percent injured shoots). From this it is concluded that the various significant differences obtained by the sampling techniques were not due to reduced sampling variation between replications, but to the relative ability of the sampling procedure in each case to accurately portray the population density.

CONCLUSIONS

These studies are part of a continuing effort designed to compare new and proven insecticides with respect to their toxicity to European

pine shoot moth larvae. Treatments were made at the time feeding was resumed in the spring and when newly hatched larvae began feeding in midsummer. All materials were applied with a 2-gallon hydraulic sprayer until the foliage was visibly wet.

Spring Treatments

The superiority of DDT as a practical insecticide for spring treatment is corroborated by these data. DDT meets the requirements of low cost, low mammalian toxicity, and high insecticidal efficiency better than any other material used in these experiments. Because there is some question about the effectiveness of DDT (and other insecticides) when applied with low gallonage equipment, e.g. mist blowers and aircraft, the performances of American Cyanamid 12880 and 18706 are of considerable interest. If, as the manufacturers believe, these materials act as foliar systemics, translocation of the material in insecticidal quantities might take place.

The timing of the applications described here favored those chemicals having good contact, residual, or fumigant action. One or more of these properties may account in large measure for the performances of 12880 and 18706. The possibility of systemic action needs to be confirmed through additional intensive timing studies where contact, fumigant or residual phenomena are not permitted to confuse the analysis.

Earlier work with Phosdrin has suggested its peculiar value as a fall treatment on seedlings. Its performance in the spring trials offers additional evidence of its toxicity to shoot moth larvae which are on or in the plant at time of application. Sevin and Perthane at comparatively high dosages give evidence that they might be useful under certain conditions.

The performances of three spreader-stickers were not adequately evaluated since Tetram, Phosdrin and BHC performed well without the additives. However, Kepone plus Plyac gave results significantly better than the check and Kepone plus DA-70 was inferior to Kepone alone. The differences noted will make possible a more intelligent approach to future work.

Summer Treatments

The importance of proper timing of summer application is illustrated by the uniformly poor control obtained with all treatments

at Rose Lake on June 24, in contrast to the population reduction resulting from application of American Cyanamid 12880, Shell Chemical Company SD 4402, Phosphamidon, DDT, and two DDT in oil formulations at Mesick on July 9. Apparently a toxic residue should persist on the plant throughout the late hatching period if control is to be successful.

By multiplying mean numbers of live larvae per injured shoot (based on dissection of five shoots per tree) times the total number of injured shoots counted in the same plot (based on a 25 shoot per tree sample) an estimate was obtained of the total numbers of shoot moth survivors present in the respective Mesick plots at the time of sampling. Such estimates can prove useful in future ecological studies or in providing more precise data where needed to reflect smaller population differences.

JOURNAL ARTICLE ABSTRACTS

The Experimental Use of Stainless Steel Femoral Head Prostheses in Normal Dogs and Cats

Brown, Roger E.

The North Am. Vet. 34:423-428. 1953. (Journal Article 1504 from the Michigan Agricultural Experiment Station)

The technic and the results of the insertion of stainless steel femoral head prostheses in small animals are described. There has been normal movement, absence of pain and, to date (5 months), no undesirable sequelae. Encouraging results in experimental work with animals suggest the possibility of its use in restoring functional coxofemoral articulations in clinical cases.

Age and Growth of the Whitefish, Coregonus clupeaformis (Mitchill), in Big Bay de Noc and Northern Lake Michigan

Roelofs, E. W.

Transactions of the Am. Fisheries Society 87:190-199. 1958. (Journal Article 2003 from the Michigan Agricultural Experiment Station)

On the basis of age composition of fish taken from commercial nets in 1949 and 1950, the whitefish in Big Bay de Noc are believed to form a population separate from that of northern Lake Michigan.

There has been a change in the age structure of the commercial catch of whitefish in Big Bay de Noc during the period, 1949 to 1954. In 1949 and 1950, several year-classes contributed to the catch, but after 1950, age-III fish provided 85 to 90 percent of the annual catch. Reasons for the change in age structure are discussed.

Annual differences in growth of whitefish in Big Bay de Noc were noted. The largest year-class produced during the study period also showed the greatest first year's growth. Older age-groups of fish also grew more during this year than did fish of the same age in other years.

Some Electrophoretic Characteristics of Two Protein Components of the Fat-Globule Membrane of Normal Cow's Milk

Brunner, J. R. and C. T. Herald

Jour. of Dairy Sci. 41:1489-1493. 1958. (Journal Article 2067 from the Michigan Agricultural Experiment Station)

Soluble proteins of the fat-globule membrane were studied electrophoretically in various buffer systems ranging from pH 2.05 to pH 8.79 at 1° C. One small and two large migrating boundaries were observed under conditions of maximum electrophoretic resolution.

The protein of the insoluble fraction was solubilized by protein-solubilizing agents such as sodium sulfide, sodium lauryl sulfate, or dodecyl benzene sodium sulfonate in alkaline solutions. Electrophoretic mobility patterns for these solu-

bilized protein samples exhibited a single, homogeneous boundary for the sodium sulfide-treated protein, whereas the detergent-treated sample(s) were heterogeneous, showing one relatively small and two major migrating boundaries. The small boundary could be eliminated from the electrophoretic pattern by heating the solubilized protein solution to 75° C. momentarily.

Effect of Stock-scion Interrelationships on the Transport of P^{32} and Ca^{45} in the Apple

BUKOVAC, M. J.; S. H. WITTWER AND H. B. TUKEY

The Jour. of Hort'l. Sci. 33:145-152. 1958. (Journal Article 2097 from the Michigan Agricultural Experiment Station)

A consideration of the absorption and transport of P^{32} and Ca^{45} in apple stions (McIntosh/EM IX, VII and XVI and Delicious seedling) grown in solution cultures revealed that the absorption and transport of P^{32} by the roots and foliage and Ca^{45} by the roots closely paralleled the vigor observed in these stions under field conditions. Rooted layers of EM IX, VII and XVI absorbed increasing amounts of P^{32} from solution cultures in the order listed. Well formed bud unions did not significantly obstruct the downward transport of foliar-absorbed P^{32} or the upward transport of root-absorbed P^{32} and Ca^{45} during the first 96 hours following the isotope treatment.

The Carbohydrates in Alfalfa Medicago Sativa. I. General Composition, Identification of a Non-Reducing Sugar, and Investigation of the Pectic Substances

LAGOWSKI, JEANNE M.; H. M. SELL; C. F. HUFFMAN AND C. W. DUNCAN

Archives of Biochem. and Biophysics 76:306-316. 1958. (Journal Article 2141 from the Michigan Agricultural Experiment Station)

A quantitative study of first and second cutting alfalfa was made to subdivide the carbohydrate fraction and to determine the ratio of various assimilates. A parallel study was made of the leaves, stems, and flower heads to locate these constituents in the plant. Appreciable differences were found between the chemical composition of first and second cutting alfalfa. The validity of using 17 percent KOH to remove hemicellulose from holocellulose was established. A non-reducing sugar was isolated from alfalfa and identified as sucrose. X-ray powder photographs taken from a pectinic and pectic acids preparation and from a comparable preparation of citrus pectic showed the two preparations to be identical.

Observations on the Lodging Resistance Formula

GRADIUS, J. E.

Agron. Jour. 50:263-264. 1958. (Journal Article 2142 from the Michigan Agricultural Experiment Station)

The lodging resistance formula works well within groups of morphologically similar varieties of oats. This formula states that lodging resistance is proportional to the force a plant is capable of withstanding divided by the height of the plant. When the formula failed, the failure was found to be due to variation in area of heads. In winter barley this factor was not as important as for oats. Data on the torque due to wind on various parts of the shoot appear to explain the aberrant readings.

A Procedure for Labeling Bloodspots in Chicken Eggs with Radioactive Phosphorus

STILES, P. G.; R. K. RINGER AND L. F. WOLTERINK

Poultry Sci. 37:600-601. 1958. (Journal Article 2144 from the Michigan Agricultural Experiment Station)

Bloodspots formed after the P^{32} labeled cells have been injected show detectable radioactivity if the spots contain more than 0.024 ml. This technique may be used to determine the total blood volume in a hen and in a bloodspot by comparing their counts per minute per unit of volume with the counts per minute of the volume injected. More important, however, the method can be used to determine the time a bloodspot forms in hens with known ovulatory cycles.

Since P^{32} is lost from the cells very rapidly, the procedure gives activity confined to the bloodspot only if the cells are injected within a few hours of bloodspot formation. If the time between injection and bloodspot formation is increased, the yolk also becomes radioactive. Activity appears in the excreta within 15 minutes.

The Effect of Gibberellins on Internodal Tissues of Phaseolus vulgaris L.

FEUCHT, JAMES R. AND DONALD P. WATSON

Am. Jour. of Botany 45:250-522. 1958. (Journal Article 2170 from the Michigan Agricultural Experiment Station)

Seedlings of Phaseolus vulgaris L. were treated with 20 micrograms of gibberellin using corresponding paired non-treated plants for comparison. Microscopic studies of the first and third internodes of plants 48 and 72 hours after treatment indicated that application of gibberellins not only increased the length of internodes of the seedlings, but also increased the number and size of cells in a linear direction. The cellular responses were similar to those observed in seedlings of *Hyoscyamus niger* (Sachs and Lang, 1957). Although cell numbers were increased substantially, cell elongation was primarily responsible for the increase in internodal length.

Some Factors Affecting Carcass Grade in Steers

MAGEE, W. T.; R. H. NELSON; G. A. BRANAMAN; L. J. BRATZLER AND A. M. PEARSON

Jour. of An. Sci. 17:649-655. 1958. (Journal Article 2178 from the Michigan Agricultural Experiment Station)

Data from 62 yearling Hereford and Angus steers which were fed 180 days or longer and managed alike throughout their life were used as one part of the study. In these data, gain had a larger direct effect than age, final weight, or area of loin eye on the carcass grade of the steers, accounting for .11 of variation in carcass grade. All the factors taken together accounted for .34 of the variation in carcass grade. The direct effect of area of loin eye on carcass grade was essentially zero.

Data from 42 older and larger Hereford steers fed 98 days were also analyzed. In these data, only final weight had a significant direct effect on carcass grade, accounting for .11 of the variation. Age of the individual steers was not known.

Irrigation of an Alfalfa-Ladino Clover-Bromegrass Dairy Pasture in Michigan

TESAR, MILO B.; E. H. KIDDER AND G. M. WARD

Agron. Jour. 50:517-520. 1958. (Journal Article 2179 from the Michigan Agricultural Experiment Station)

Alfalfa-Ladino clover-bromegrass dairy pastures irrigated with 3⅓ inches of water annually during a 3-year period under a humid climate produced 17 percent more forage and 18 percent more milk (because of increased carrying capacity) than when not irrigated. An inch of applied water increased forage production by 0.20 ton.

Irrigation was not profitable based on a replacement value of $25.00 per ton of dry forage produced and a cost of $5.11 per acre inch of water applied.

Irrigation of a Ladino Clover-Bromegrass Sheep Pasture in Michigan

TESAR, MILO B.; L. H. BLAKESLEE AND E. H. KIDDER

Agron. Jour. 50:514-517. 1958. (Journal Article 2180 from the Michigan Agricultural Experiment Station)

Ladino clover-bromegrass sheep pastures irrigated with 4½ inches of water annually during a 4-year period under a humid climate gave 23 percent more forage and 22 percent more lamb gain than non-irrigated pastures. Forage production was increased an average of 0.16 ton per inch of applied water. Irrigation helped maintain clover in the pasture.

Based on a replacement value of $25.00 per ton of dried forage and an annual irrigation cost of $4.03 per acre inch of water, irrigation resulted in a net loss of $.13 per acre.

Bovine Fetal Hemoglobin I. Postnatal Persistence and Relation to Adult Hemoglobins

GRIMES, R. M.; C. W. DUNCAN AND C. A. LASSITER

Jour. of Dairy Sci. 41:1527-1533. 1958. (Journal Article 2183 from the Michigan Agricultural Experiment Station)

The postnatal persistence of bovine fetal hemoglobin, and its relation to adult hemoglobin F, were investigated by electrophoretic methods. Fetal hemoglobin, which at birth made up 41 to 100 (average, 87) percent of the total, diminished rapidly and was replaced entirely by hemoglobin A in 14 bull calves at an average age of 65 days. With four heifer calves the average was 97 days. In two Guernseys and one Brown Swiss, the ratio of A to fetal hemoglobin approached 1.0 at about 65 days and remained at this level. No A appeared in the blood of a Guernsey and a Jersey from birth to 67 and 83 days. Fetal hemoglobin migrated more rapidly during paper electrophoresis than did A, but at the same rate as that of F. Moving boundary electrophoretic mobilities and relative concentrations of components of globins prepared from F and fetal hemoglobins were approximately equal. Although it is not considered conclusive, the evidence suggests that fetal hemoglobin and hemoglobin F may be identical.

Prediction of Acorn Crops

GYSEL, LESLIE W.

Forest Sci. 4:239-245. 1958. (Journal Article 2191 from the Michigan Agricultural Experiment Station)

Possibilities of determining the size of acorn crops by counting the number of flowers or immature acorns were tested. All counts were made on tall mature trees of the red oak white oak groups with a spotting scope, generally with a 30X eyepiece.

If no flowers are produced, the acorn crop of species of the red oak group will be a failure 16 to 18 months later. Lack of flowers on trees of the white oak group would result in a poor crop during the same year. If flowers are produced, acorns may or may not develop from them. Losses of immature acorns may also occur at any time. Therefore there appears to be no absolute method for an early prediction of the size of mature acorn crops if flowers and immature acorns are produced. Early predictions can indicate the potential size of a crop; however, the actual size can be determined only by later observations or check counts.

Sugar Beet Production in Michigan as Affected by Cropping Sequence and Fertility Level

GUTTAY, J. R.

Jour. of the Am. Soc. of Sugar Beet Tech. 10:66-75. 1958. (Journal Article 2201 from the Michigan Agricultural Experiment Station)

Sugar beets following alfalfa in sequence have lower yields and sucrose percentage than beets grown after an intervening crop of white pea beans or corn. Beets produced the year after sweet clover in full blossom has been plowed down, yield higher and have a higher sucrose percentage than beets produced following corn after alfalfa.

Sugar beets produced in cropping systems utilizing sweet clover seedings previous, in sequence, to beets and supplemental nitrogen yield equally as well as beets produced following corn after either a one or two year old alfalfa sod. Supplemental nitrogen has not benefited sugar beet yields where beets are planted within 2 years after a good alfalfa sod.

Yearly variability of yield and sucrose content is attributed mainly to precipitation. Sugar beet yields decrease with increasing spring rain and sucrose content is lower with high rainfall prior to harvest.

Effects of Cortisone Acetate on Milk Production and Mammary Involution in Parturient Rats

JOHNSON, ROBERT M. AND JOSEPH MEITES

Endocrinology 63:290-294. 1958. (Journal Article 2202 from the Michigan Agricultural Experiment Station)

Two similar experiments were performed on 68 parturient rats to determine the effects of cortisone acetate on lactation and mammary involution. The lactational response was measured by the effects on growth rate of the litters during

the first 18 days postpartum. In the first experiment, 0.5 mg. of cortisone acetate daily elicited a significant increase in average litter weight gain over the control litters. A dose level of 1.0 mg. of cortisone acetate daily produced a slight but insignificant gain in average litter weight over control litters, despite a loss of over 15 percent in body weight by the mother rats. In the second experiment, daily doses of 0.5 or 1.0 mg. of cortisone acetate, induced significant litter weight gains over control litters. When litters were removed on the 18th day postpartum, and cortisone acetate injections were continued for an additional 10 days, mammary involution was significantly retarded.

The Effect of Starvation and Subsequent Refeeding on Some In Vitro Activities of Rumen Microorganisms

MEISKE, J. C.; R. L. SALSBURY; J. A. HOEFER AND R. W. LUECKE

Jour. of An. Sci. 17:774-781. 1958. (Journal Article 2203 from the Michigan Agricultural Experiment Station)

The steer used in these experiments received hay plus a small amount of concentrate. When feed was withheld for 72 hours, rumen pH rose to as high as 7.9 and the ability of the rumen fluid to digest cellulose decreased to a very low level. The activity of some rumen fluid fractions against a soluble cellulose derivative, carboxymethyl cellulose, was also lowered.

When feeding was resumed, rumen pH dropped rapidly, then rose to a normal level, cellulose digestion returned to normal in three to four days, and all rumen fluid fractions showed an unusually high activity against carboxymethyl cellulose before returning to normal levels.

No differences could be atributed to the kind of hay used before or after the starvation period.

Withholding feed for 72 hours did not cause loss of appetitie, nor was there evidence of digestive disturbance when feeding was resumed.

Kinetics of Potassium Release from Biotite

MORTLAND, M. M.

Soil Sci. Soc. of Am. Proc. 22:503-508. 1958. (Journal Article 2205 from the Michigan Agricultural Experiment Station)

Optical and X-ray diffraction data show that weathering of biotite to vermiculite proceeds from the outside edge in toward the center of the particle. The 14A layers were found to have about four times the diffraction intensity of the 10A layers. Observation was made of the actual weathering front. The dependence of rate of potassium release on leaching rate, NaCl concentration, temperature, time, and particle size was evaluated and an empirical equation derived relating these variables. A theory is presented that the apparent zero order type of reaction results from the maintenance of a constant concentration of reactive potassium similar to the principle of a saturated solution of a material in equilibrium with its solid phase. The logarithmic portion of the curve is suggested as the place where a "saturated solution" of reactive potassium can no longer be maintained and rate of release becomes dependent upon the amount of unreacted potassium.

Hormonal Control of Mammary Growth and Lactation in the Goat

NELLOR, J. E. AND E. P. REINEKE

Jour. of Dairy Sci. 41:789-795. 1958. (Journal Article 2206 from the Michigan Agricultural Experiment Station)

Mammary growth and lactation were induced in kids and mature goats by weekly injections of macrocrystalline stilbesterol alone, or of macrocrystalline progesterone and stilbesterol in combination at ratios of 40:1, 80:1, and 1.000:1. Sexually mature goats were distinctly more responsive to the treatments than 8-month-old goats. Although all groups reached approximately the same peak production 7 months from the start of the experiment, a more rapid onset of lactation was noted in those groups where progesterone and stilbesterol were combined. Two goats approached closely the level of production recorded in the subsequent normal lactation. However, most of them were considerably below this level. No clear-cut indications were found for an optimum ratio between progesterone and estrogen for the induction of mammary growth and lactation in the goat.

The Effect of a Live Yeast Culture and Trimethylalkylammonium Sterate on the Performance of Milking Cows

LASSITER, C. A.; C. F. HUFFMAN AND C. W. DUNCAN

Jour. of Dairy Sci. 41:1077-1080. 1958. (Journal Article 2207 from the Michigan Agricultural Experiment Station)

Fifteen lactating Holstein cows were used in a study to evaluate the effect of a live yeast culture and Dynafac on the performance of cows.

Grain rations containing either the live yeast culture or Dynafac did not appear to have any significant effect on the production of 4 percent FCM, butterfat test or feed consumption. The cows fed the control ration gained in body weight significantly more than the other two groups of cows. Neither supplement appeared to have any effect on the over-all health and general condition of the cows.

Under the conditions of this experiment no evidence was obtained that either the live yeast culture or Dynafac improved the performance of milking cows.

Enzyme Supplements for Calves. I. Effect of Predigestion of a Vegetable Milk Replacer on Growth

FRIES, F. G.; C. A. LASSITER AND C. F. HUFFMAN

Jour. of Dairy Sci. 41:1081-1087. 1958. (Journal Article 2209 from the Michigan Agricultural Experiment Station)

Twenty-four 2-day old Holstein calves were fed a corn-soybean flour vegetable milk replacer that had been subjected to the following treatments: Control, predigested with malt diastase, predigested with papain, and predigested with a combination of these enzymes. Average daily gains at 40 days were 0.38, 0.47, 0.10, and 0.35 lb. and at 60 days were 0.65, 0.99, 0.59, and 0.73 lb. for the four groups, respectively. Dry milk replacer consumption at 40 days was 34.0, 31.5, 18.0 and 19.0 lb. and at 60 days was 90.8, 107.7, 68.1, and 102.3 lb. for the four groups, respectively. The difference in gain and milk replacer consumption at both 40 and 60 days were not statistically significant. Two calves from the papain

group and one calf from the combination group died shortly after 40 days of age. At necropsy the adrenal cortex of all three calves showed hemorrhage and/or necrosis. Milk hyperemia and some hemorrhages were noted in the alimentary tract.

The Influence of Short Term High Temperature Storage With and Without Oxygen Scavenger on the Acceptability of Precooked Irradiated Meat

PEATSON, A. M.; L. E. DAWSON; L. J. BRATZLER AND R. N. COSTILOW

Food Tech. 12:616-619. 1958. (Journal Article 2219 from the Michigan Agricultural Experiment Station)

This study was designed to determine the effects of short term high temperature storage upon the acceptability of precooked irradiated beef, chicken, pork and veal. In addition, the influence of adding oxygen scavenger (glucose oxidase) was determined for all products except chicken. Results of meat irradiated at 2.79×10^6 rads indicated that pork was affected little or none by irradiation, while acceptability was markedly lowered by irradiating beef, veal and chicken. Acceptability scores for all irradiated meats studied with the exception of pork appeared to improve with storage at room temperature or above. Although added oxygen scavenger did not significantly improve acceptability, mean scores tended to be higher when it was used. A loss of texture was apparent on storage, which appeared to be a function of time and temperature.

Interdisciplinary Considerations in Research on Feed Utilization by Dairy Cows

JOHNSON, GLENN L.

Nutr'l. and Econ. Aspects of Feed Util. by Dairy Cows, Iowa St. Col. Press. 1958. (Journal Article 2238 from the Michigan Agricultural Experiment Station)

The need for controlled experiments which are designed cooperatively by dairy and economic scientists on feeding dairy cows was presented. Necessary pre-conditions for effective cooperation as revealed by former work in fertilization were listed. Following this the basic economic laws, theories and principles relevant in the design of such experiments were developed briefly with heavy reliance on geometric presentation. The types of accuracy which are important for economic analysis were discussed and some attention was given to the roles which statisticians can play in designing experiments to attain the necessary accuracy. Finally, some words of warning and advice were given; these, as was true of the pre-conditions for effective cooperation, are based upon several years of experience in designing controlled fertilizer experiments cooperatively with soil scientists and statisticians.

Vegetable Oils in Rations for Laying Hens

EVANS, ROBERT JOHN; SELMA L. BANDEMER AND J. A. DAVIDSON

Poultry Sci. 37:977-978. 1958. (Journal Article 2239 from the Michigan Agricultural Experiment Station)

Eggs produced by hens fed rations containing 2.5 percent of crude cottonseed oil developed viscous pink whites and large salmon colored yolks after 6 months

or more of cold storage. No discoloration occurred when the hens were fed similar levels of crude sesame, safflower, tung, peanut, rice bran, linseed, soybean, or corn oils.

Influence of Some Public Assistance Programs on Forest Landowners in Northern Michigan

YOHO, JAMES G. AND LEE M. JAMES

Land Econ. 34:357-364. 1958. (Journal Article 2243 from the Michigan Agricultural Experiment Station)

Forestry aspects of four major public assistance programs—forestry extension, service forestry, Soil Conservation Districts, and the Agricultural Conservation Program—are considered in this paper. The study has been confined to a 31-county area in northern Michigan. It is based on data collected mainly in 1954 and 1955 during a field study of private forest landownership and management.

An attempt has been made to measure some of the forestry impact of the four public assistance programs on small forest landowners. In all instances, one is impressed both by the limited extent of the efforts made and the limited effects. The most successful of the programs in relation to the cost involved appears to be forestry extension.

Corn Versus Oat Silages as a Roughage for Dairy Cattle

LASSITER, C. A.; C. F. HUFFMAN; S. T. DEXTER AND C. W. DUNCAN

Jour. of Dairy Sci. 41:1282-1285. 1958. (Journal Article 2250 from the Michigan Agricultural Experiment Station)

Two double reversal milk production trials, two digestion trials, and a 46-day heifer growth study were conducted to compare corn and oat silages as roughages for dairy cattle. The studies were conducted with 1956-1957 crops. The corn was harvested in the early dent stage and the oats in the early dough stage.

Digestion trials showed that the corn and oat silages had average TDN values of 65.4 and 61.4 percent on a dry matter basis, respectively. Milk production data showed that when oat silage supplied 63 percent of the total roughage intake it was superior in feeding value to corn silage, but when the silages supplied a higher proportion of the total roughage intake (77 percent), oat silage produced significantly less 4 percent than corn silage. Cows fed oat silage consumed significantly less roughage dry matter than when fed corn silage.

Dairy heifers fed oat silage as the sole source of roughage made significantly lower average daily gains in body weight than heifers fed either corn silage or alfalfa hay. Heifers fed either oat or corn silage consumed significantly less roughage dry matter than heifers fed hay.

Some Aspects of Hygroscopic Properties and Fermentation of Honey

MARTIN, E. C.

Bee World 39:165-178. 1958. (Journal Article 2258 from the Michigan Agricultural Experiment Station)

The hygroscopic properties of honey were studied in honey samples exposed in controlled humidity chambers. Studies of yeast development at different

levels in honey exposed in high humidities were made by removing samples through the walls of beeswax containers.

When moisture was absorbed honey gradually established equilibrium with the water with the water vapor of the air to which it was exposed and 5 equilibrium points were determined. Honey lost moisture more slowly in low humidities than it gained moisture in high humidities. Water was absorbed from honey more rapidly at 20, 32 and 42 percent relative humidity than at close to 0 percent relative humidity.

When water was absorbed in excess of 21.5 percent at the surface yeasts developed aerobically on the surface in enormous numbers; while yeasts living anaerobically maintained fairly constant numbers below the surface of the honey.

Influence of Antibiotics on the Growth and Protein Metabolism of Young Dairy Calves

LASSITER, C. A.; R. M. GRIMES AND C. W. DUNCAN

Jour. of Dairy Sci. 41:1417-1424. 1958. (Journal Article 2261 from the Michigan Agricultural Experiment Station)

Twenty-one 2-day old calves were used to evaluate the effect of aureomycin and bacitracin on growth and protein metabolism. Calves fed rations containing either antibiotic tended to gain at a faster rate, consumed more calf starter and total feed, and made better utilization of their feed (feed per pound of gain) than the control calves. Both antibiotics significantly lowered the coefficients of dry matter and crude fiber digestibility, but neither antibiotic appeared to have any great effect on the digestibility of other nutrients or on nitrogen retention. Aureomycin significantly increased blood serum levels of total protein while bacitracin significantly decreased but neither had an appreciable effect on blood levels of urea or non-protein nitrogen. Both antibiotics significantly increased the relative serum concentration of albumin and lowered the concentration of alpha-globulin, but had little effect on beta-globulin concentration. Calves fed both antibiotics tended to have lower levels of serum gamma-globulin than the control calves.

The results indicate that these antibiotics had very little effect on over-all digestion and protein metabolism of the calf.

The Effects of Gibberellin on Economic Crops

WITTWER, S. H. AND M. J. BUKOVAC

Econ. Botany 12:213-255. 1958. (Journal Article 2262 from the Michigan Agricultural Experiment Station)

This is a review article of recent research developments in crop production with gibberellin. Increased yields and dry matter accumulation in a variety of crops without significant changes in composition have been reported. Gibberellin partially or completely replaces the effects of light and photoperiod in seed germination, vegetative growth of herbaceous and woody plants, and flowering of long day plants. The effects of temperature in the breaking of dormancy and flowering of biennials and winter annuals are partially or completely replaced. Growth, including seed germination, is activated at low temperatures. More uniform and earlier flowering and larger inflorescences can be induced in some species. Fruit setting, large fruit size, and earlier maturity, and greatly increased

yields have been reported for seedless and seeded grapes, figs and citrus. Twenty-five responses induced in plants by gibberellin heretofore not subject to chemical regulation are outlined, and promising agricultural applications are given.

Experimental Leptospirosis VI. Histopathology of the Bovine Placenta in Leptospira Pomona Infection

MORTER, R. L.; R. F. LANGHAM AND E. V. MORSE

Am. Jour. of Vet Res. 19:785-791. 1958. (Journal Article 2263 from the Michigan Agricultural Experiment Station)

One of seven pregnant heifers infected with *L. pomona* aborted about 29 days following infection.

Leptospiras were not isolated from the aborted fetus or any of the six fetuses which were viable at the time the dams were killed. Direct infection of the bovine fetus did not appear to be responsible for the abortions under these conditions. A series of histopathological changes was found in the cotyledons which could interfere with the development of the fetus and result in fetal death and abortion.

Some Preliminary Studies on Meat Flavor

KRAMLICH, W. E. AND A. M. PEARSON

Food Res. 23:567-674. 1958. (Journal Article 2268 from the Michigan Agricultural Experiment Station)

This investigation was undertaken to characterize and ascertain the intensity of flavor in various beef and beef juice fractions. Raw and cooked beef water slurries, raw and cooked press fluid and filter cake, and raw and cooked meat water leachings with the various filtrates, both before and after heating, were used. A dilution technique for the determination of the flavor threshold was used to express the intensity of flavor. The character of the flavor varied greatly between the raw and cooked fractions, yet upon heating the raw fractions, the flavor appeared to differ only in intensity. The flavor of the press fluid was highly concentrated. Extraction of both raw and cooked meat showed the flavor constituents to be largely water soluable. The cooked meat leachings, however, had a higher flavor threshold than did the raw meat leachings indicating that full flavor development may be due to heating of the juice and fibers together.

Theoretical Considerations in Materials Handling Systems

HALL, CARL W.

Ag. Engr. 39:524-529, 539, 551. 1958. (Journal Article 2279 from the Michigan Agricultural Experiment Station)

The development of materials handling systems is one of the major factors in the development of agricultural mechanization. Materials handling entails equipment plus its proper management and use. In order of convenience, materials handling may be classified as liquid, free flowing, and non free flowing. The operation with the lowest cost is not necessarily the optimum. The system with the greatest net return is desired. Location of storage units at the center of moments of the load X distance gives an erroneous and misleading result.

To minimize handling the storage should be located at the point of maximum demand. Components can be selected and evaluated with respect to the systems through mathematical programming. The application of the transportation technique and simplex technique for linear programming is presented.

Application of Newton's Equation to Moisture Removal From Shelled Corn, 40 to 140° F

HALL, CARL W. AND JORGE H. RODRIGUEZ-ARIAS

Jour. of Ag. Engr. Res. 3:275-280. 1958. (Journal Article 2299 from the Michigan Agricultural Experiment Station)

Shelled corn in a thin layer was found to obey closely in exponential drying law, analogous to Newton's law of cooling. The drying constant applicable for the particular range and moisture contents concerned were used for applying the simple exponential equation. The time of ½-response, with other conditions remaining constant, is affected the greatest by temperature, and secondly by initial moisture content. The time of ½-response is shortened as the initial temperature is increased and as the initial moisture content is raised. The number of constants obtained for a drying relationship was the same as the number of molecular layers of moisture adsorbed in the pores, as calculated according to the classical B-E-T equation.

The Quarterly Bulletin

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents progress reports on long-term major research projects and final reports on short-term projects.

SPEAKER-HINES AND THOMAS, INC., LANSING, MICH.—1959